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ABSTRACT

This guide is a result of two years' piloting and revising the Science Curriculum Improvement Study (SCIS) program for the students of Guam. The life science portions of SCIS were chosen and adapted for the ecology of the area. Program flexibility is stressed and outdoor activities are encouraged. Used in grade one, the topic of organisms is divided into six parts, including seeds and plants, classroom aquaria, habitats, algae, food web, and detritus. Each part is then organized into 16 chapters or learning activities. These activities emphasize the SCIS philosophy of student exploration, invention, and discovery. Included in each investigation is information on teaching materials, preparations, and optional activities. At the end of the guide is an appendix with learning activities especially adapted to the ecology of Guam, and a glossary of terms. (MA)

LIFE SCIENCE FOR GUAM
Teacher's Guide

ORGANISMS

Grade One

"....to ultimately graduate citizens who are knowledgeable and conscientious about environmental concerns of Guam and the rest of the World."

Adapted by Jeffrey E. Shafer

Guam Environmental Curriculum Project
Department of Education, Agana
1974 Edition

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Beyond that, giving the credit due the hundreds of individuals, including the students, who have aided in developing this project is probably impossible. With apologies for omissions, here is the roll of contributors to the unfolding of "Environmental Education for Guam Schools":

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Appreciatively submitted, October 1974

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Dave Hotaling
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PREFACE

In 1969 a project proposal, "Environmental Education for Guam Schools", was submitted to the ESEA Title III Advisory Council. After a number of revisions the proposal was approved in July 1971, and the program got under way.

A Task Force of interested citizens was formed and periodically contributed to the movement of the project.

The Biosciences Division of the University of Guam presented a special course for elementary teachers on the Ecology of Guam, compliments of the project.

A general consultant visited Guam and offered valuable assessments and recommendations.

It was decided that the most feasible procedure would be to adapt for Guam the relevant ecology portions of a successful Mainland science program, the Science Curriculum Improvement Study (SCIS), developed by the University of California, Berkeley. Accordingly, and with the permission of publisher Rand McNally, four Guam naturalists took up the task and adapted the Life Science sections of SCIS for grades one through six.

You now have the results of that adaptation, and two years' piloting and revision, in your hands. (Our 1974 production has concentrated on the grade one Teacher's Guide.) Other teachers and their students on the Island have used this program with enjoyment and success. Although some pilot teachers had the advantage of prepared kits of materials, there should be little trouble in finding similar items, which are common, inexpensive (even free)

and unsophisticated. The organisms, including seeds, also are common on Guam and for the most part can be obtained with a bit of ingenuity.

Even when the Department of Education budget includes this program --expected in the near future-- it will be teachers who do the actual ordering (and probably some of the obtaining). In the meantime, your students, colleagues, principals, consultant, local merchants, and Department of Agriculture may help.

The results will be worth your efforts!

Our approach places emphasis on:

1. Doing activities;
2. Having students observe, interpret, describe, compare, classify measure and experiment;
3. Having the teacher provide materials and guidance but not lecture;
4. Giving the students opportunities to make discoveries for themselves;
5. Encouraging students to talk about their experiences in their environment;
6. Having the teacher provide the students with time for inquiry, experimentation and discussion.

SCIS PROGRAM

Life Science Sequence

1. Organisms
2. Life Cycles
3. Populations
4. Environments
5. Communities
6. Ecosystems

Student Manuals accompany Teacher Guides

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PROGRAM OVERVIEW

The first year. The unit Organisms has certain objectives: to sharpen the students' powers of observation, discrimination, and accurate description. The objectives are accomplished as students care for aquatic plants and animals and raise seedlings.

ORGANISMS. Children become familiar with some of the requirements for life as they set out seeds and watch the growth of plants. This experience is extended when the class builds aquaria with water plants, fish and snails. Three natural events occurring in the aquaria are observed and discussed: birth of guppies and appearance of snail eggs, growth of guppies and snails, and death of organisms.

When they explore the school yard, nearby park, or nature area, children discover plants and animals living outside the classroom. Your students are led to the concept of habitat as they compare these land organisms with those living in the aquaria.

After a few weeks, the algae in some of the aquaria increase in sufficient numbers to make the water green. The children usually notice this change and sometimes ask about its cause. Through a series of experiments and observ ations they recognize the presence of tiny green plants called algae. Children may then find evidence that algae are eaten by Daphnia (water fleas) or other small crustaceans. When they discover that guppies or mosquito fish feed upon crustaceans, the children can use this series of observations as the basis for understanding the concept of a food web

depicting feeding relationships among organisms.

Detritus, the dark material accumulating on the bottom in aquaria after several days, is a combination of feces and dead plants and animals. Children infer as they compare seeds grown in sand with and without detritus, that it acts as fertilizer, enhancing plant growth.

Each experience with living organisms should increase the child's awareness of differences between living organisms and non-living objects.

The second year. The second year unit is Life Cycles, in which the theme is change, observed as the development of animals and plants. The unit, therefore, requires students to add the mental process of interpreting evidence to the observational skills developed in the first year.

LIFE CYCLES. The investigation of ecosystems begun in Organisms is continued in Life Cycles. The unit, however, focuses on individual organisms, which alone show the characteristics of the phenomenon we call "life." At this time the interrelationship and interdependencies within the ecosystem have secondary importance.

Each kind of plant and animal has its own life cycle. By studying the life cycles of selected plants and animals, children observe the characteristics of living organisms. Seeds are planted and their germinations observed. Plants are cared for until they reach maturity, produce flowers, and form a new generation of seeds. The fruit fly, toad, and beetle are observed while they metamorphose (change body form). As one generation of organisms produces another, children are led to consider biotic potential

and the effects of reproduction and death on a population. Finally, when some of the similarities and differences between plants and animals have been considered, and children have defined the two categories on the basis of their own observations, they proceed to the more general question, "What is alive?" With each experience, a young person's awareness of the differences between living and nonliving objects should increase.

The third year. Students observe and experiment with increasingly complex phenomena and move toward understanding the ecosystem concept. In Populations they observe the interactions of various organisms within a community of plants and animals and consider the interdependence of individuals and populations within the community.

POPULATIONS. In this unit, attention is directed toward populations of organisms rather than toward individual plants and animals. Students observe the growth, eventual leveling off, and decline of isolated populations of Daphnia or other small crustaceans, aphids, and fruit flies. They relate increased population sizes to reproduction and population decline to death.

The children build aquaria and terraria in which several populations live together. The aquaria contain populations of tiny crustaceans, fish, snails, algae, duckweed, and Hydrella. The terraria contain grass and other plants, grasshoppers, and lizards. By observing the interacting populations in the aquaria and terraria, students gain some understanding of the relationships among populations in nature. For example, they observe that

fish eat small crustaceans, with the result that the crustacean population declines while the fish population may increase. In the terraria, the students observe that grasshoppers eat plants and that when lizards are added to the terraria they eat the grasshoppers. Thus, the plant populations are reduced, and the grasshopper population is eventually wiped out.

The fourth year. In the life science unit Environments, students consider for the first time some of the physical conditions that shape an organism's environment. It is important that the students be able to describe the changes they see with increased precision so they may deal more effectively with such topics as behavior of organisms and their own environment.

ENVIRONMENTS. The terraria students design and build at the beginning of the unit reflect their preconceptions regarding the needs of organisms. As a result, there is a wide disparity in the growth and survival of the organisms living in the terraria, and these differences can be correlated with variations in environmental factors such as temperature, amount of water, and intensity of light. The term environment is defined as the sum total of all the external factors affecting an organism.

Afterwards, the students seek to relate the responses of individual kinds of animals and plants to variations in the environmental factors. On the basis of experiments with isopods in a runway with graded temperature, the concepts of a temperature range and of an optimum range for that animal are introduced. In additional experiments, the pupils attempt to determine optimum ranges of other environmental factors for snails,

beetles, beans, grass and other plants. Before the unit is concluded, the students again construct terraria, but now they use their data on optimum ranges to establish a more favorable environment for their organisms.

The fifth year. The conceptual development of the SCIS program continues as examples of food (energy) transfer are introduced. Students apply interpretation of environmental factors during the unit.

COMMUNITIES. In the Communities unit, the pupils investigate the food relations within a community of plants and animals. They experiment with germinating plants, discovering that food stored in cotyledons is consumed; however, another source of food, photosynthesis, supports the plants' growth.

The students observe the feeding behavior of animals in terraria containing various plants and animals. They identify the food chains and infer that photosynthesis in green plants supplies food not only for the plants but also for the animals in the community. The students count the large number of wheat seeds eaten by grasshoppers and the few grasshoppers eaten by a single toad. On the basis of these data, the food pyramid is introduced.

When an animal or plant in the terrarium dies without being eaten by another animal, the students place the dead organism in a vial and cover it with moist soil. They observe the organism's gradual decomposition along with the appearance of mold or an unpleasant odor. The students are told that organisms that satisfy their energy needs by decomposing

the bodies of dead plants and animals are bacteria and molds.

The transfer of food through a community is illustrated by means of a chart showing the food relations among plants, animals, bacteria, and molds. The plants are identified as producers, the animals as consumers, and the molds and bacteria as decomposers. The interacting producers, consumers, and decomposers in a given area constitute the community.

The sixth year. The last year of the SCIS program contains both a climax and a new beginning. The Ecosystems unit integrates all the preceding units as the students investigate the exchange of matter and energy between organisms and their environment.

ECOSYSTEMS. Through the investigations in the Ecosystems unit, students become aware of the roles played by oxygen, carbon dioxide and water in the maintenance of life. When this understanding is combined with the habitat, populations, community, and other concepts introduced in the SCIS life-science sequence, the term ecosystem acquires its full meaning.

Initially, the pupils review the ideas introduced in the five earlier units by building a composite terrarium-aquarium. The organisms living in the containers represent plants, plant eaters, and animal eaters - organisms that flourish under varying environmental conditions. An ecosystem is "a community of organisms interacting with its environment".

After observing water droplets on the inside of the terraria-aquaria, students clarify the role of water in an ecosystem. The water cycle refers

to the succession of evaporation and condensation of water.

The students study the carbon dioxide-oxygen exchange between organisms and their environment. They test their own preconceptions about oxygen and carbon dioxide when they compare the gases formed by plants exposed to light and to the dark, by animals living in a community with plants and by animals in isolation. The production and consumption of the two gases is described as the carbon dioxide-oxygen cycle.

The food-mineral cycle is introduced. And, finally, the concept of pollution is officially presented.

CLUES FOR THE TEACHER

Outdoor Activities

An obvious and necessary portion of any program in environmental education is that the students get outdoors and see as much of Guam as possible. There are many places on the island offering field trip opportunities --- your own schoolyard, the nature trails, limestone forest, reef flats, glassbottom boat, Mt. Lamlam, Agana Spring, Mt. Alutom savanna, mangrove swamp, trails to several waterfalls, Sella Bay ---- and many more. Take advantage of all you can!

As you plan your science classes keep in mind that the SCIS teaching program is not organized into tightly structured lessons. Rather, a unit is composed of several parts, each having specific objectives. The parts, in turn, are divided into chapters. Each chapter may contain several activities.

One activity may extend beyond a single class period, or several may be included in one session. Certain activities are intended for small-group or independent study. Other activities will be more successful when a larger group or the whole class works together.

Your willingness to improvise and to depart from your lesson plans will better enable you to meet your pupils' needs. Sometimes students will ask questions that do not lead in the direction you planned. If that happens, permit yourself and the class the pleasure of a side trip that may lead to fruitful experiences. In addition, encourage pupils to explore some of their

questions independently.

The learning cycle. The SCIS program provides for three stages in a child's learning cycle. These stages, which we term exploration, invention, and discovery, are explained more fully below. They are based on current theories of how children learn.

Exploration. Youngsters learn through their own spontaneous behavior relative to objects and events: that is, by handling objects and by experimenting with them. In the first learning stage, therefore, students explore the materials with minimal guidance in the form of instructions or specific questions. The materials have been carefully chosen to be easily used and to generate certain questions that the pupils have not asked before.

Invention. Spontaneous learning is limited by the child's preconceptions. After exploration, he needs new concepts to interpret his observations. Since few young people can phrase new concepts by themselves, you must at times provide a definition and a term for a new concept. This constitutes the "invention." Be clear and explicit when you give a definition, repeating it several times if necessary. To give the students opportunities to use the new concept, encourage them to look for examples that illustrate the idea. When they report such examples immediately or during later discovery activities, you gain feedback about their understanding of the concept. The conclusion of an invention lesson may turn into a free-ranging discussion of the validity of these examples.

Discovery. We use the word discovery for those activities in which a young person discerns a new application for a concept. You may plan a variety of

situations leading to discovery or you may depend on a child's own experiences to furnish these applications. The young people's discovery activities reinforce the original concept and enlarge and refine its meaning. In this way mastery and retention of concepts are aided by practice and repeated, wide application. Discovery is most effective when there is considerable variety in the examples investigated so that repetition occurs with respect to the concept illustrated.

Discussions. Conversation among students or between teacher and students is an important part of the learning process. While participating in individual or group experiments, children spontaneously exchange observations and ideas with one another. During an invention session, the teacher illustrates and explains a new concept. When gathering feedback, the teacher may address a specific question to a particular person.

On other occasions, we suggest discussions in which the students report on their experimental results, compare observations and sometimes challenge one another's findings. Many should participate in these discussions, and you, the teacher, should avoid controlling the topic or the pace. Encourage them to comment to each other without specifically calling them to recite in turn. Grouping them to face inward around an open area promotes their speaking to one another. If you call attention to disagreement between two findings, you invite evaluative comments and suggestions from the class.

Asking questions. The questions you ask and the way you ask them will affect the work and attitudes. Note the difference between "What did we study yesterday?" and "What did you find out yesterday?" Both questions call

for a review of a previous activity, but the former seeks an answer already in the teacher's mind, while the latter inquires into another person's own experience.

Questions that aim for a predetermined answer are often called convergent because of their specific goal. Most questions in multiple-choice tests are of this nature, as are many questions asked by classroom teachers. Questions that allow a variety of answers are often called divergent because they may lead in many directions. Provocative discussion questions are usually of this nature.

Adjust your questions to your purpose in asking them. If you wish to spark discussion, ask a divergent question and then sit back while several people propose answers. Examples of such questions are "What evidence of interaction did you observe?" or "How could we find out what made the sand turn dark?" You achieve one of your objectives if the discussion continues without your leadership.

If you wish to gather feedback about a particular pupil's understanding or recall of a certain fact, ask him a covergent question. This may well be done individually, perhaps while small-group work is in progress. Examples are "Did the waterfleas touch anything in this experiment?" or "What interacted with the bromothymol blue?"

Optional activities. Optional activities have been included in many chapters to keep the teaching program flexible. These make use of the regular equipment or require paper clips, construction paper, scissors, and other readily available items. You may use the optional activities for several purposes,

such as:

1. To extend the main activities if a student raises a related question.
2. To provide additional discovery situations for individual pupils who complete their assignments early or who show a special interest in the unit.
3. To emphasize one topic for the entire class.
4. To expand the unit quite extensively if your class is older than those for whom it is principally designed.
5. To relate the science program to math, social studies, language arts, and as many others as your talents permit.

We hope that you will include at least a few of the optional activities in your program but we do not expect you to use all of them.

Language development. During extensive use in urban, rural, and suburban schools the earlier editions of the units proved to be particularly helpful as part of the overall effort to improve children's oral language skills. The experience with real and interesting materials was especially effective in the case of disadvantaged or deprived children whose desire to speak and participate in class discussions increased dramatically.

Children new to the SCIS program. Some of your pupils will be unfamiliar with the SCIS program. While most of them will be able to participate effectively, a few may have difficulty because they lack background or are not accustomed to working independently. You can make the transition easier for them in several ways.

First, by using the review of previous units and extending it with activities from those units, you can help children who are not familiar with the concepts they need. These activities may be used individually or in groups,

as your feedback indicates.

Second, you can help a young person become secure in independent work by showing that there are many acceptable procedures and results. Encourage him to find various ways to use a piece of equipment (dip net, paper, rubber band, medicine dropper, and so on), approve of his ideas, and let him share his findings with others.

Student manual (Grades 4 - 6 only). The student manual is merely one teaching aid and is not the mainstay of the course. During some activities the pupils record information about their experiments in the manual, which is referred to for later discussion. Encourage the young people to make their entries independently even though their reports may disagree with those of other students or with what you consider to be the "correct" response. Some students may later change their minds. In that case, let them indicate their new responses with additional entries and cross out the first one. That way their original record is preserved. In addition, the manual contains some problems for them to solve independently and others for class discussion. Much of the manual would not make sense in the absence of the classroom activities.

The student manual is one of many bridges you can use to help young people better understand the relationship between the world of concrete objects and the world of words, abstractions, and ideas.

Feedback. Feedback is information that comes to a person in response to something that person did. As a teacher, you are receiving feedback from

your pupils most of the time. An answer to a question yields feedback. So does a child who looks out the window during your demonstration. In addition, the "Optional Activities" include suggestions for evaluating feedback through special procedures designed for this purpose. Plan to examine the student manuals periodically, not to grade a person's work but rather to gather evidence of the quality of his understanding. If you confer with individual students, you may discover the reasoning behind some of the statements made in their manuals.

LIFE SCIENCE FOR GUAM
(Elementary Environmental Curriculum Project)
GRADE 1 - ORGANISMS

Suggested Equipment and Organism List (for a class of 28).

Planter Materials	30	planter cups
		plastic tray or bases (to prevent planter cups from leaking onto table or floor)
	2	light sources
	4	packets seeds (such as achoti, basil, mustard, radish, ryegrass, bean, local watermelon, mung bean, pumpkin, birdseed, etc.)
	3	water sprinklers
	14	paper plates
	1	roll labels
		bag of soil
Aquaria	14	"1-gallon" clear containers, or substitute (e.g. Tang jars)
	1	class aquarium
Aquaria Materials	28	plastic tumblers
	2	dip nets (coarse & fine)
	1	package fish food
	1	bottle plant nutrient
	14	medicine droppers (plastic)
		bag of sand
		stirring stick
Filtering Materials	1	baster (i.e. giant-size medicine dropper)
	1	roll labels
	14	plastic funnels
	1	package cotton balls
Small Containers	55	plastic bags (medium size)
	55	twistems
	14	plastic tumblers
	14	small jars (ex: baby food jars) or vials

Miscellaneous		Daphnia film loop	seeds
		Butcher paper roll	pond snails
	14	magnifiers	guppies, mosquito fish etc.
		paste	hydrella, duckweed
		sissors, crayons	small giant African snails
			waterfleas or mosquito larvae

PART 1
SEEDS AND PLANTS

OBJECTIVES FOR THE STUDENT: At the end of Part 1 the student should be able to:

...describe seeds and grow plants from seeds.
...state some requirements for seed germination and plant growth.

BACKGROUND INFORMATION AND SUGGESTIONS: A mature seed contains a small plant embryo plus stored food within a protective cover or seed coat. After the seed has been soaked in water, the coat softens and breaks open. The embryo plant uses up the food supply as it grows into a seedling. Green plants need minerals, water, air and light in order to remain healthy. Minerals and water present in the soil are taken in by the plant roots. Air passes into plants through tiny pores in the leaves. Light may be provided artificially by a 75 or 100 watt bulb.

The students should discuss how often plants need to be watered before they separate into watering groups. Some may carry out other experiments at the same time, such as planting seeds at various depths of soil, upside down, or on a moist sponge. These activities may be carried out with the aquarium investigations in Part 2. The committee approach works well in exercises that call for cooperation. If seeds are old they will not germinate properly. Bringing in seeds that man eats may be helpful in teaching these concepts. Try popping corn and eating it in class or use other eatable seeds such as peas, corn beans, coconut, birdseed.

CHAPTERS IN THIS PART:

1. What Do Seeds Look Like? The students observe different kinds of seeds. They plant seeds in soil-filled containers. Time: 1.5 weeks

2. How Do Plants Grow? Students observe plants and report changes. You direct their attention by asking questions about growth rates or properties. This same activity may be used for any local seeds planted if desired. Time: 4.5 weeks and observe until mature.

CHAPTER I

WHAT DO SEEDS LOOK LIKE?

WHAT YOU WILL BE DOING:

The students observe different kinds of seeds. They plant seeds in soil-filled containers.

TEACHING MATERIALS:

For each team of two:

Two different small seeds-radish, ryegrass, basil, mustard, achoti, birdseed.
Two different large seeds-pumpkin, local watermelon, bean, mung bean (mongos)
Two planter cups (or empty milk containers)
Two planter bases (or two large trays for the class)
One paper plate
Two labels
One magnifier

NOTE: You may wish to use other local seeds. Do not use hot pepper (donne' sali) ---it burns. Make sure you choose a variety of sizes; from very small to quite large so the students will have no trouble classifying them. Try sprouting seeds yourself before giving them to the class to sprout. Generally, soaking the seeds for 24 hours on moist paper towels will be enough time for them to sprout. If they do not sprout by then do not use them in class.

For the Class:

one bag of soil
water sprinklers
two large plastic trays

THINGS TO DO IN ADVANCE:

Prepare enough paper plates for one-half your class, each with two seeds of each type. Provide three stations in the classroom for the distribution of the planters, soil and magnifiers. If you use milk cartons be sure to punch a few holes in the bottom so excess water can drain out, otherwise the seeds will no doubt rot before they sprout.

HELPFUL HINTS:

The children should be divided into groups of two. Give each team a paper plate with the seed mixture. Ask the students to observe the seeds with their magnifiers, and sort them into groups. The seeds in each group should have the same properties, i. e. be alike. Show the children how to hold the lens close to one eye and then move the object back and forth until it can be clearly seen. In all cases the children's interest should determine the extent to which they explore. Ask questions similar to the following:

How are seeds different from other objects?
How are some seeds different from other seeds?
How are some seeds the same as other seeds?

CLASS ACTIVITY: Planting Seeds

One member of each team may plant beans and ryegrass (or radish) while the other plants squash and corn. Radishes grow well in sandy soil so you may wish to add some sand to your soil.

NOTE: It is important that each "farmer" plants both large and small seeds.

Let each student obtain a planter cup with soil and a base (if trays are used there will be no need for bases).

Show your class how to plant the bean and squash seeds in the soil, as follows: Generally, the large seeds should be planted about one inch deep and covered gently with soil. Smaller seeds, such as ryegrass and radish, may be sprinkled on the surface and then covered with a thin layer of soil. Each student should label his planter with his name. Let students indicate on a large chart at what level in the soil they planted their seeds.

Watering:

After planting, ask how often the cups should be watered. On the basis of their responses, divide the class into two groups --- one recommending little watering and one recommending frequent watering.

Let students set up watering schedules. Remind the "farmers" frequently about watering or better yet, let them establish a system to remind themselves.

If any students, for any reason, want to change the watering frequency --- let them as long as they explain their reasons to you.

The teacher should plant four planters with seeds, and water them three times a week, more heavily on Friday and Monday. This will ensure the growth of some healthy plants for the class to observe at the end of the experiment.

If enough students express a desire to plant more seeds, encourage them to bring in various seeds: betelnut, mango, coconut, papaya, tangentangen, pea, watermelon, pumpkin, lemon, flowers, etc. Have them plant and observe the plants in the next activity. Some children may even wish to transplant their seedlings to areas around the school yard. By all means encourage it. Ask your school principal to designate a "planting area" on the school ground for this purpose.

OPTIONAL ACTIVITIES:

You and your students may want to use the following ideas for more activities about seeds. These activities have been suggested by teachers already using the materials and have proved valuable to them.

1. Will a seed grow in water only?
2. Will a seed grow on a wet sponge or paper towel?
3. How does the Department of Agriculture plant seeds? Take a field trip!
4. What foods at the store are seeds?
5. Will seeds found around school grow? (Those pesky burs you pick up)
6. Do all plants grow from seeds? Use carrot tops, potatoes, garlic, onions, flower cuttings.
7. [Your own suggestion(s)........]
8.
9.
10.

CHAPTER 2

HOW DO PLANTS GROW?

WHAT YOU WILL BE DOING:

Students observe their plants and report changes. You direct their attention by asking questions about growth rates or properties.

NOTE: This same activity may be used for any local seeds planted if desired.

TEACHING MATERIALS:

For the class:

seedlings from Activity 1
light source (75 or 100 watt bulb and reflector. A "Gro-lux" lamp is appropriate also.)

THINGS TO DO IN ADVANCE:

This activity requires enough surviving seedlings from Chapter 1 so the students can observe changes. If the seedlings die or fail to grow you will need to secure healthy plants. One plant that seems to grow extremely well is sweet basil. Plant several of these seeds two weeks before this activity. The class, once the plants are mature, can even dry the basil, crush it and take it home for their mothers to use in cooking.

HELPFUL HINTS:

Make sure as soon as the seedlings appear above ground they receive enough natural or artificial light. If you use an artificial light source, arrange for the custodian to leave the lights on overnight. Temperate zone summer and tropical plants receive at least 12 hours daylight. Ask questions so the children may relate what they have observed:

Which type of seed sprouted first?
Which plants are growing fastest?

Students should also be questioned about their watering experiments:

What happened to the plants that were watered least?
How much water is best for plants?

CLASS ACTIVITY:

Should the plants bend, find out if your students noted this (if not call it to their attention) and ask the possible causes. If light is suggested, ask them how the plants might be straightened without being touched. (Simply turn the planters so the plants face away from the light.) If other bending ideas are offered, encourage testing of these ideas in class.

When the activity has run its course, interested students may take their plants home for maintenance indoors or transplanting outdoors. Be sure you maintain at least seven plants for the activity with the giant African land snail in Chapter 9.

OPTIONAL ACTIVITY:

1. Draw out from the students a suggestion that the class start a small garden at school.

2. If you have not already done so take a field trip to the Department of Agriculture.

3. Have the class plant an herb garden in a flat box, (basil, parsley, garlic, etc.).

4. How do different plants grow? - Using different seeds, (pumpkin, squash, pea, etc.) see if all seeds grow in the same manner by placing seeds on moist towels.

PART 2
CLASSROOM AQUARIA

OBJECTIVES FOR THE STUDENT:
At the end of Part 2 the student should be able to recognize and describe:

...reproduction, birth and death.
...feeding, growing and other events occurring in aquaria.

BACKGROUND INFORMATION AND SUGGESTIONS: These organisms will probably be present in your class aquaria:

Hydrella - grows in a slow stream, backwaters, and ponds. Although it it grows well when just floating, the plant may develop roots and become anchored in the aquarium sand. Pond snails are frequently found on Hydrella leaves. Agana Springs is a good source for Hydrella.

Eelgrass - commonly occurs along the edge of lakes. In aquaria, eelgrass usually propagates rapidly by means of runners.

Duckweed - often forms a green mat on the surface of ponds or slow-moving streams. Ducks, fish and snails eat Duckweed.

Water Snails - frequently climb on plants, rocks, and other submerged objects. Small ones sometimes hang from the surface film of water. Many snails eat soft plant tissue, but some are scavengers, feeding on dead plants and animals. Fish and large insects prey on snails. Some snails themselves are predators.

Guppies and Mosquito Fish - are born live.* Mosquito fish were introduced into Guam waters in an attempt to control mosquito populations. They do not reproduce as well in captivity as guppies. Therefore, obtain guppies for reporduction activities. You may wish to keep a large aquarium for the class with mosquito fish. Mosquito fish will thrive on dried fish food, although their natural diet consists of living organisms such as Daphnia and mosquitoes in various stages of development. Note that the mosquito

*Footnote Page 8.

fish's mouth is located in the upper part of the head; ask your students if they know why. (We need not go into a long evolutionary explanation --- it enables the fish to eat food floating on the surface of the water.)

Green Algae - There are several species of single-celled green organisms belonging to a group of relatively simple plants, algae. Each organism reproduces by dividing into two and under favorable conditions so many individuals result that the water will become green.

Aged Tap Water: You will need varying quantities of "aged" tap water for the activities using aquatic plants and animals. We suggest that you prepare and store it in a large container, so it will be available at all times. It should be kept covered to keep out dust and insects.

NOTE: Set out a "habitat board" now, for use in Chapter 8. To do this, secure a flat board of any manageable size but with at least 100 square inches of surface area. Place it on grass or bare soil in the school yard where it will not be disturbed but where the children can visit it easily.

CHAPTERS IN THIS PART:

3. How is the Freshwater Aquarium Set Up? Students prepare aquaria to receive mosquito fish, (guppies) snails and Hydrella. The organisms are then emptied into the aquaria along with some duckweed, and eelgrass. Time: 2.5 weeks.

4. How Are Mosquito Fish Different from Each Other? Either students or teachers ask questions concerning the identification of male and female mosquito fish or guppies. The children carry out experiments to find answers. Time 1.0 week to discuss, and observe for 10.5 weeks.

5. How do Mosquito Fish and Snails Reproduce and Grow? The students discover young fish and snails in the aquaria. Students observe them periodically to discover any changes that might occur. Time: Not certain - watch aquaria.

6. What Happens to Dead Organisms? When a dead organism is discovered in an aquarium, it is left undisturbed so the students can observe what happens to it. Time: Not certain - watch aquaria.

NOTE: If no events occur, or if the children do not ask questions about birth, death, or sex differences, immediately proceed to Part Three but keep a watchful eye on the aquaria. Feed the fish one time per week.

*Note to Page 7: Unlike most female fish, which lay eggs, female guppies and mosquito fish hatch eggs internally and the young come out as tiny swimming fish, hence the word "live".

CHAPTER 3

HOW IS A FRESHWATER AQUARIUM SET UP?

WHAT YOU WILL BE DOING:

Three days before the organisms for this activity are obtained, the class prepares six aquaria to receive them. Six groups are formed with each group receiving an aquarium. When the organisms are obtained, the small fish, snails and Hydrella are placed in plastic cups so pairs can observe them. The organisms are then emptied into the aquaria along with some Duckweed, Hydrella and more snails. In Chapter 3 the students build six one-gallon aquaria. Then they observe and report on the contents and events that occur in Chapters 4-6.

TEACHING MATERIALS:

For each two students:

- 1 pond snail
- several Duckweed plants
- 1 guppy or mosquito fish
- 1 plastic tumbler
- 1 magnifier

For each of the six groups:

- 1 one-gallon container
- 1 label
- 2 cups washed sand (optional)

For the class aquarium:

- 1 jar of algae water
- Hydrella
- Duckweed
- Guppies
- 1 class aquarium
- 1 bottle liquid plant nutrient
- 1 medicine dropper
- 1 dip net
- 1 package fish food
- 1 light source
- 1 crayon

THINGS TO DO IN ADVANCE:

Let the students help you prepare the aquaria. Prepare six gallons of aged water by letting tap water sit for 48 hours uncovered. This allows chlorine in the water time to evaporate.

> CAUTION: At no time should you use soap to clean the containers. Tap water will do fine.

Fill each of the six containers 3/4 full with aged tap water. Rinse the sand several times, then add 2 cups to each aquarium. After the students have left the room, add 1/6 of the jar of algae water to each of the six aquaria. This event is intended to pose a problem for the class, and it will ensure the appearance of "green water."

> NOTE: Ideally, each aquarium should receive natural light (not direct sunlight). However, your room may not have good natural lighting. In this case arrange for a "Gro-lux" or other artificial light to be on 24 hours per day including weekends and holidays.

HELPFUL HINTS:

Be sure to identify each new organism and write its name on the board. Ask questions designed to gain feedback on the students' observational skills:

How does a mosquito fish move?
How many fins does the fish have?
Where is the fish's mouth?
How do snails move?

CLASS ACTIVITY:

After the children have had a chance to observe the aquaria for 15 minutes or so, conduct a class discussion and ask the above questions. Encourage them to draw pictures of the organisms. Have several children pantomine how a snail and a fish move through the water.

> NOTE: Keep at least one gallon of aged tap water handy so that the students may replace any water lost by evaporation.

Have the class place their aquaria in different parts of the room. Be sure three are placed in a darker part of the room and three near the light source. Do not place any aquaria in direct sunlight.

In the discussion group accept all responses. If students disagree on something encourage them to make further observations. Let them observe their aquaria

for short periods each day and encourage them to report anything new. Events to look for:

- Birth of mosquito fish (Chapter 5)
- Appearance of snail eggs (Chapter 5)
- The death of an organism (Chapter 6)
- The changing water color (Chapter 9)
- Accumulation of detritus (Chapter 14)

A day or so after setting up the aquaria, carry out the activities in Chapter 4. Then go on with Part Three while you await the birth of mosquito fish. Wherever appropriate (after the first organism dies) carry out the activities in Chapter 6. When the children notice "green water" Parts Three and Four may be done concurrently.

DO NOT START PART FIVE OR PART SIX UNTIL FOUR HAS BEEN COMPLETED.

OPTIONAL ACTIVITIES:

1. Write a class letter to Woody Owl, c/o U.S. Department of Agriculture Forest Service, Washington, D. C. 20250. Woody will send a 9"x12" poster on pollution.

2. Have the class keep count of the numbers of fish and snails in the aquarium over a period of time. Ask them to let you know if there are any changes.

Chapter 4

HOW ARE MOSQUITO FISH DIFFERENT FROM EACH OTHER?

WHAT YOU WILL BE DOING:

Teachers ask questions concerning the identification of either students or male and female mosquito fish or guppies. The students carry out experiments to find answers.

TEACHING MATERIALS:

For the class:

2 one-gallon containers
1 dip net (coarse mesh)
1 package fish food
6 aquaria (prepared in Chapter 3)
1 light source

THINGS TO DO IN ADVANCE:

Have two gallons of aged tap water ready.

HELPFUL HINTS:

The class should notice that some guppies (mosquito fish) have properties different from those of others. Ask them how they can find out which are males and which are females. Tell them that mother fish are females and father fish are males. What evidence would your students look for to establish which fish are female? Discuss the differences. Seek explanations. No doubt sex will be one explanation.

The students should offer suggestions for experiments. Help them carry out these experiments. One procedure you should suggest, if none of the students do, is the separation of the fish by appearance. Add aged tap water to two one-gallon containers. Using the coarse dip net, add approximately eight females to one, and isolate about four males in the other. Then watch the ones in which the baby mosquito fish appear. Add Hydrella and Duckweed plants to both aquaria. Add a tiny pinch of fish food two or three times per week.

CLASS ACTIVITY:

The children should observe the aquaria after young have appeared. Of course, if the children are fortunate enough to witness the birth of a baby mosquito fish, they will have direct evidence to tell them which are females.

Ask the children if they can distinguish the sexes in other organisms. Do they know any kinds of organisms in which males and females look alike? The pond snails in the aquaria can not be different because each individual is both male and female. Show pictures of organisms with sex differences and see if the students can distinguish them. Many plants, e.g. papaya, cycad (fadang or federico palm), pandanus (pahong, etc.) come in separate sexes.

OPTIONAL ACTIVITIES:

1. As a teacher you may wish to set up a class salt water aquarium. If so, see Appendix page 51.

Chapter 5

HOW DO FISH AND SNAILS REPRODUCE AND GROW?

WHAT YOU WILL BE DOING:

The students discover young fish in the aquaria. They also find snail eggs on plant leaves or on the aquaria walls. After their initial observations, the children periodically observe the young fish and snail eggs to discover any changes that might occur.

TEACHING MATERIALS:

For each team of two children:

1 magnifier

For the class:

8 aquaria (prepared previously)
1 package fish food
crayon
2 labels

THINGS TO DO IN ADVANCE:

Inspect the aquarium carefully before the students arrive. Locate the snail eggs so you will be familiar with their location.

HELPFUL HINTS:

Ask the students to count the fish and to write the numbers on a label applied to the aquarium wall. The students should then keep daily counts.

On the day the fish are born, ask the students how big they are. The students can not measure the young, but they might be able to estimate their size in comparison to the adult fish. Regardless of the answers, you will have drawn their attention to the relative sizes of adults and young in one species.

CLASS ACTIVITY:

Let the students feed the young fish. A tiny pinch of fish food given two or three

times per week is adequate. Do not use more; uneaten food can contaminate the aquaria.

Snail Eggs:

Clusters of yellowish, transparent spheres, each one the size of a pinhead, may appear on the sides of the aquaria and on the leaves of the plants. These are snail eggs. To focus the attention on eggs that have been laid against the aquarium wall, circle the eggs with a crayon on the outside. If eggs have been laid on a leaf, you can move this to a separate container for closer inspection.

The students should watch the eggs through a magnifier. Eventually, a small brown, opaque spot will appear in each sphere, becoming larger day by day. Ask the students what they think it is. After a week or two, a very small snail will hatch. The class will notice this event primarily because the dark spots in the egg mass will have disappeared.

Further discussion may involve the following, teacher-asked questions. Let any student who wishes, conduct his own experiments to find the answers to these questions:

> Which mosquito fish seems to be taking care of the babies? (Let the class first note whether any mosquito fish seem to take care of the small ones.)
>
> Can the babies live without their mothers?
>
> Will another mother take care of the babies?
>
> Where do the babies spend most of their time?
>
> Do the babies eat with the adults, or do they eat later, or out of the adults' way?
>
> Does the snail egg have to stay in the water to hatch?.
>
> How many snails come from one egg?
>
> How many eggs does one snail lay?

Cleanup:

Return the organisms to the students' aquaria. Wash and store the containers.

OPTIONAL ACTIVITIES:

1. Have the students write an illustrated experience story about the "birth" of fish and snails.

2.

3.

Chapter 6

WHAT HAPPENS TO DEAD ORGANISM?

WHAT YOU WILL BE DOING:

When a dead organism (probably a fish or snail) is discovered in an aquarium, it is left undisturbed so the students can observe what happens to it.

TEACHING MATERIALS:

For the class:

1 aquarium containing dead organisms

HELPFUL HINTS:

This chapter can be taught only when an organism dies. If a death does not occur, go on to Part Three and return to this chapter at the appropriate time. If there are dead animals in several aquaria, remove them from all but one.

CLASS ACTIVITY:

Ask the students to observe and report the changes that occur. Possibilities are:

1. The water may turn cloudy and white as the bacteria and protozoa feeding on the dead fish multiply.

2. Green algae may be seen, first around the dead organism and then throughout the aquarium. The decaying organic matter acts as a fertilizer, promoting growth of algae.

3. A fuzzy white mold may develop on a dead fish.

4. A white scum, possibly including some decay products, may appear on the surface of the water.

5. There may be some red and black material among the sand grains.

6. A dead fish may float. Gases produced during its decomposition are trapped inside the fish, causing the fish to rise to the surface.

7. There may be an offensive odor.

Ask the students what is happening to the dead body. Accept whatever answers they give. This specific question is intended to stimulate thinking and not to lead to any specific answer.

We suggest that you develop a method of disposing of dead organisms before disposal becomes necessary. The students may suggest wrapping the dead animal in a paper towel and putting it into a garbage can.

OPTIONAL ACTIVITIES:

1. A field trip to the beach or Agana Springs with specific intent to observe evidence of dead organisms and decaying might be appropriate here.

PART 3
HABITATS

OBJECTIVES FOR THE STUDENTS:
At the end of Part 3 the students should be able to:

...understand the term "habitat" and use it to refer to a place where an organism lives.
...describe diverse habitats of organisms ordinarily found in the school area.

BACKGROUND INFORMATION AND SUGGESTIONS: The term environment refers to everything influencing or affecting the life of an organism. It includes the surface of the earth, the atmosphere, the sun, air temperature, other organisms and their effects. Any organism's particular environment is its habitat --- the place where it lives.

Saltwater habitats exist in the seas, oceans, and salt flats of the world. Minute plants and animals (plankton) live in the upper layer of the open ocean. In the shore areas that are twice daily covered and uncovered by the tides, there are the habitats of a great diversity of living creatures.

The land, too, contains a variety of habitats --- the cultivated garden hosts flowers, snails, and aphids; the farm (ranch) is the habitat for cattle, chickens, pigs and vegetables; fields, sidewalks and building cracks abound with cockroaches and the Guam "daisy" (beggar's tick); the limestone forest contains many ancient plants native to Guam, and the savanna hosts swordgrass and scattered trees with the various animals associated with them.

In the Organisms unit, experiences relating to the habitat concept begin with the cultivation of plants in the classroom and the building of aquaria. They continue (in Chapter 7) with the class field trip to observe plants and animals living near the school yard. The "habitat" concept is introduced in Chapter 8 on the basis of the children's experience with aquaria.

CHAPTERS IN THIS PART:

7. Where Do Organisms Live? The class takes a field trip to search for organisms and learn where they live. This activity is intended to be an exploratory experience preliminary to the invention of the habitat concept.

8. What Is A Habitat? The invention of the habitat concept is based on the students' experiences with aquaria. Discovery activities depend on the children's past experiences, available books, and the "habitat board."

9. How Do Land Snails Live? Children observe a giant African snail and potted plant.

CHAPTER 7

WHERE DO ORGANISMS LIVE?

WHAT YOU WILL BE DOING:

The class takes a field trip to search for organisms and learn where they live. This activity is intended to be an exploratory experience preliminary to the invention of the habitat concept. IMPORTANT: Always prep the students before going out.

HELPFUL HINTS:

Students should be able to find plants and animals in and around the school yard. There is a very fine nature area at Agana Springs; however, weeds, a tree, or bushes around the school yard will serve the objectives in this activity. Survey the school site and nearby areas for a suitable destination prior to the class trip. Restrict the territory in which children will search. In a smaller plot, the children will spend more time looking, less time running, and so observe more organisms.

Tell your students that they are to look for as many organisms as they can find and to notice where these plants and animals live. Exact identification is not necessary. When a child comes upon an organism that neither you nor the others can identify, simply give it a descriptive name such as "little black bug" or "large blue flower." If only a few animals are found, ask the children to look for evidence of animal life such as leaves with edges chewed off; small holes in leaves, tree bark, or in the ground; and feces and possibly parts of dead organisms.

Plants should be easily observed, but animals may be more difficult to locate. Tell your pupils to look for them on the ground, under rocks, around the base of a tree, and on the leaves and branches of bushes. Caution them to replace any rocks or other objects they move during their search for hidden animals. Return to the classroom before the children lose interest in the search. After the trip the children may report on the kinds of plants and animals they found and describe the habitats. Your pupils may wish to draw pictures about their experience, and to staple these into a booklet about their trip.

OPTIONAL ACTIVITIES:

1. Place half an apple or potato in a spot where there are not many animals. Two or three days later, look around and under the apple for changes.

2. Find some cut weeds or grass and make a pile on the ground about six inches high. Two or three days later, bring all the grass and weeds into the classroom and search through them for organisms.

3. If the students find organisms while on the field trip, ask them to reconstruct the habitat in the classroom.

4. The Agana Springs Nature Preserve handbook contains specific suggestions for preparing students to go into the field. You may obtain a copy from the Guam Science Teachers Association and local bookstores, approximately $2.50.

CHAPTER 8

WHAT IS A HABITAT?

WHAT YOU WILL BE DOING:

The invention of the habitat concept is based on the children's experiences with aquaria. Discovery activities depend on the children's past experiences, available books, and the "habitat board."

TEACHING MATERIALS:

For the class:

1 one-gallon container
2 cups sand (optional)
1 dip net (coarse mesh)
6 aquaria (prepared in Chapter 3)
1 habitat board

THINGS TO DO IN ADVANCE:

Have ready one gallon of aged tap water. Rinse enough sand for one aquarium. A habitat board should have been set up two or three weeks before beginning this chapter.

HELPFUL HINTS:

The activities in Chapters 2, 3 and 7 served as exploration experiences on which the invention of the habitat concept is based. The concept is introduced in this chapter, and the students are encouraged to discover habitats outside the classroom.

Invention:

Construct another aquarium for the invention of the habitat concept. In front of the class, pour rinsed sand into an empty container and then add aged tap water. After the sand has settled to the bottom, state that the aquarium is now a "habitat" where certain kinds of organisms can live. Tell the children that a "habitat" is a place where a plant or animal lives, and write the word on the board. Ask what organisms now in the room they would place in the new habitat, and transfer these organisms to the new container. After the transfer has been completed,

repeat that you have made a "habitat" where these organisms can live. Ask the students to describe the new habitat.

Ask the students if they can think of any place outdoors where there are habitats like this aquarium. Make sure you point out freshwater habitats such as Agana Springs, and the 50+ rivers on Guam if the children do not. Don't forget puddles.

Ask the children to describe the habitats of other organisms that may be in the classroom, such as mice, houseplants, the seedlings planted in Part One of this unit, or turtles. What is the habitat of each of these organisms, and how does each differ from the aquarium habitat?

Discovery:

Two or three weeks after you have placed the habitat board (or boards) on the ground, take your class to visit the spot. Lift the board and let the students observe the organisms; then return the board to its original position. Let the students see the habitat often, always replacing the board. "Natural" habitat boards (fallen trees, overgrown boards) are often better.

Ask the students to name other habitats. If there is little response, suggest that they look for some on the way to and from school. If you ask the question again the following day, they will probably have many ideas to offer.

OPTIONAL ACTIVITIES:

1. Drawings:

   Individuals can draw pictures of plants and animals in their habitats and share these pictures with their classmates. The whole class might construct a mural showing habitats. The drawings, plus the following activities, can give you feedback concerning the children's understanding of the habitat concept.

2. Books:

   Children can look through books and magazines to find, and perhaps cut out and display, pictures of habitats. It would be appropriate for you to read aloud stories about organisms and their habitats. Films and children's vacation snapshots might provide further examples of habitats.

CHAPTER 9

HOW DO LAND SNAILS LIVE?

WHAT YOU WILL BE DOING:

Children observe a giant African snail and potted plant.

TEACHING MATERIALS:

7 one-gallon wide mouth jars
7 potted plants (the plants from Chapter 1 may be used)
7 giant African land snails

THINGS TO DO IN ADVANCE:

Before beginning the activity invite one member of each group to bring in a small African snail. Let everyone who wants to bring in a snail do so. A gallon jar should be large enough to hold four snails and one plant.

In class, make sure the following questions are asked before you begin the activity:

1. What Do Snails Eat?
2. What Do Land Snails Look Like?
3. How Do They Move?
4. How Do They Protect Themselves?

CLASS ACTIVITY:

Set the potted plants on a flat surface covered with paper towels. Have the children place the snails near the plant. Cover the plant with the jar. For a few minutes each day have the children observe the plant and snails and report anything new.

> NOTE: Snails consume plants and do extensive damage to gardens. They are able to crawl up plants by contracting and relaxing muscles in their foot. They also secrete a slimy substance from their foot which helps them stick to leaves and stems. Rats, shrimps and coconut crabs are known to feed on snails. Small snails seem to have bigger appetites, hence their use in this activity.

The snail-plant relationship is a good example of producer-consumer concept. The giant African snail is a scavenger and will eat the dead remains of other snails. On Guam, many instances of snails eating housepaint have been reported.

Some students may want to experiment to find out if this is true. Encourage it by all means. Further research is needed on this before a definite conclusion is reached.

OPTIONAL ACTIVITIES:

1. Have the children "write" an experience story about the snails and plants.

NOTE: About giant African snails, rats, and the rat lungworm which can cause a form of meningitis in humans. Where rats and snails live together (e.g. Taiwan, S.E. Asia, Hawaii, Guam) snails, slugs, shrimps and crabs can become intermediate hosts for the lungworm of the rat. Humans and monkeys and pigs who eat unrinsed vegetables containing infected slugs or snails, or inadequately-cooked snails, shrimp (such as in kelaguen), or crab, stand a chance of picking up the disease.

It's probably unnecessary to caution youngsters not to eat raw snails; they aren't all that appetizing! No cases of this meningitis have been reported from mere handling of the African snails, even by researchers who handled thousands of infected ones in order to study the parasite's life cycle. One researcher cut three fingertips and held them for 15 minutes in a bowl of water which contained 4000 parasites--results: NONE.)

Five experts, four of them doctors in this field, have independently advised us that classroom use is safe and educational. Make your own choice, but now you can be prepared if approached by some worrywart or other.

(Details are available from the Epidemiologist at Public Health, and office of the Environmental Science Consultant, 6th floor Pedro's Plaza, Agana.)

PART 4
ALGAE

OBJECTIVES FOR THE STUDENTS:
At the end of Part 4 the students should be able to:

...describe changes in the color of the water in aquaria.
...collectively propose and test hypotheses about the changes in the color of the aquarium water.
...draw conclusions from group data.

BACKGROUND INFORMATION AND SUGGESTIONS:

Algae:

Algae are organisms that, like other green plants, are able to photosynthesize; that is, use energy from light to convert minerals, water, and carbon dioxide into food and oxygen. Algae have no roots, stems, leaves, nor flowers. In addition, red, brown, or blue-green pigment may be predominant in some algae instead of the green pigment of familiar land algae. In freshwater habitats, algae may appear as dense mats of green filaments floating on the surface of ponds and ditches or as filaments attached to rocks. On the ocean shore, algae as diverse as red crusts, green "seaweeds," and massive brown kelps can be found attached to rocks. Some kinds of freshwater algae require little moisture for growth, and these are often found as green films on fences, tree bark, and mud. Many algae are so small that the individuals can be seen only with the aid of a microscope. When large numbers of them are present in ponds and aquaria, the water has a characteristic green color.

Green Algae:

The cause of green water is green algae which have multiplied rapidly since you added them to the aquaria. Algae may also be brought into aquaria on fish, snails, or plants. It may take a week, or more than a month, for the aquaria you placed under the light to become green and opaque. Whenever this happens, children will probably notice the change and ask questions like, "Why did the water get green?" or "Where did the green water come from?"

These and other questions are investigated in Chapter 10. Some experiments should be designed by the children, and others may be teacher-directed.

NOTE: Make sure you order water fleas as soon as the water turns green.

CHAPTER 10

WHAT MADE THE WATER GREEN?

WHAT YOU WILL BE DOING:

The students ask about the cause of green aquarium water after noticing the color change. At the same time you ask for their ideas. Student responses are recorded and used in the design of classroom experiments, which they set up with your help. The experiments are carried out with the expressed purpose of discovering the cause of the green color.

There is, however, a more fundamental objective --- to introduce the children to a simple laboratory experience. They should learn how to carry out experiments properly and to understand the relation of investigation to general knowledge.

TEACHING MATERIALS:

For the class:

2 planter cups
2 planter bases
1 package ryegrass seeds
3 sprinklers
1 dip net
1 package labels

5 to 10 tumblers

6 aquaria (prepared in Chapter 3)
1 bag soil
cotton (optional)

THINGS TO DO IN ADVANCE:

Have ready 3 to 6 gallons of aged tap water.

HELPFUL HINTS:

When the water in the aquaria has turned so green and opaque that the children notice and inquire about it, ask them what might have caused the color change. Their ideas will provide the basis for some of the experiments in this chapter.

No one can predict what a child will state as an explanation for green water, but here

are some ideas that children have expressed:

"Plants melt in the sun."
"Fish eat plants then spit them out."
"Dead snails make it green."
"Maybe, water just turns green."

Record all the children's ideas so they can be used to suggest experiments for the class to do.

CLASS ACTIVITY:

The class should design an experiment to compare two setups that are alike in every way but one. That one difference is the variable that is to be tested. For example, if a child suggests that plants are responsible for the green water, compare two aquaria --- one with and one without plants. Every other variable in the aquaria must be alike; sand, fish, snails, and the positioning of the aquaria in the classroom. You will probably have to help the children set up their experiments.

Here are some ideas that can be carried out in your classroom:

Light:

Light of a certain intensity is necessary for algae to grow. Your pupils can infer this fact by comparing the aquaria located on the light side of the room with those receiving less light. The aquaria containing green water received more light. To test this supposition, move one of the aquaria containing clear, colorless water from the darker to the lighter side of the room and observe it over a period of time. In this move, you have changed two variables. In the lesser light the aquarium did not become green. If it does so now in the stronger light, the idea that the amount of light has something to do with the change is supported.

In order to show that light is essential for green plants, put some ryegrass seed into two planters filled with soil and add water. Place one close to a light source; put the other in a dark place --- in a closet or under a box. Check both planters every few days, and water them as necessary. After a week or two, compare seedlings grown in dark with those grown in the light. You will see that seedlings develop in both containers but there are great differences between the two. Where seedlings exposed to light are green and have long roots, those kept in darkness are yellow, taller than the others, and have very small roots. If you continue this experiment, you will find that the yellow seedlings soon die.

Your students may not infer that what is green in the water may also be a kind of plant. Let them continue to experiment without trying to force the conclusion.

Fish - Snails - Large Plants - Sand:

If the children suggest that fish, snails, large plants, sand, or other factors cause the green water, let them experiment. First, discuss how the experiment should be conducted, then help them set it up using the tumblers. Ask the children what results they expect. Place a record of the experiment and the predicted results beside the tumblers. Later, the class can compare the results obtained with their predictions.

"It's Algae."

There may be one or two children in your class who will report with an air of finality that "algae's making the water green." Ask them what they think algae are and how they can find out whether or not algae can be separated from the water, in other words, treat this as you would any of the children's ideas --- experiment.

Do not expect your pupils' experiment to produce dependable results. However, the children have had an opportunity to (1) think about the design of an experiment, (2) attempt to carry it out, (3) observe the results, and (4) draw conclusions. If several aquaria turn green, then they are receiving too much light. If this happens the students may become bored and uninterested. Be sure there is a minimum of light on the aquaria on the dark part of the room.

Results of the Experiments:

Discuss the results of each experiment. Ask the groups what ideas they were testing, their predictions, the results, and their own conclusions from the experiments. Do not force them in any prescribed direction.

As a demonstration filter some of the "green" water through cotton or filter paper. Make sure the children understand that the filter lets the water through but not the "green" stuff. Place this "green" filter into a small jar of aged tap water. Place the jar in the light and have students observe over a period of two weeks. When this water turns green, discuss and remind the students of previous times when the water turned green.

Cleanup:

When the results of all the experiments are known and have been discussed, you may wish to return the contents of the experimental containers to the original aquaria. If you do so, be sure not to discard any green water; it will be used in subsequent activities.

PART 5
FOOD WEBS

OBJECTIVES FOR THE STUDENTS:
At the end of Part 5, the student should be able to:

...identify organisms that others eat in the aquarium.
...use the term "food web" to refer to the feeding relations among organisms.
...represent a "food web" with a diagram.

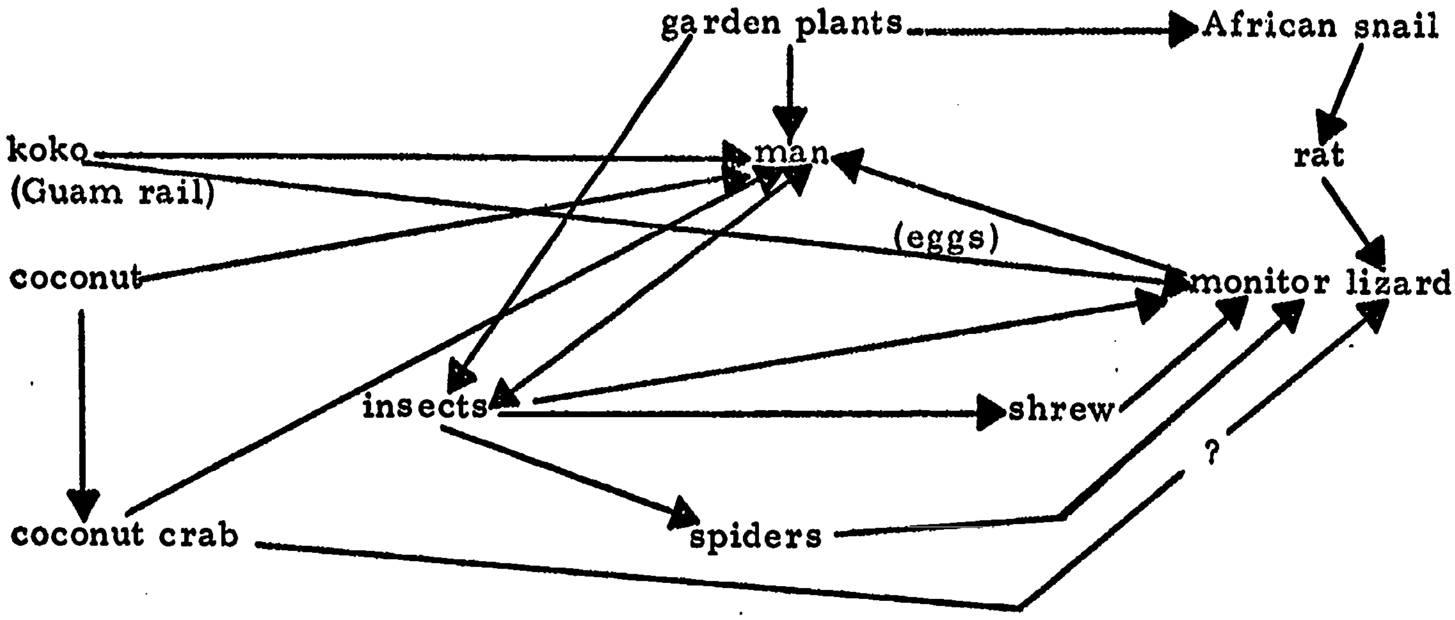
BACKGROUND INFORMATION AND SUGGESTIONS:

In the previous description of ecosystem, it was mentioned that a community is maintained by a complex of interactions among plants and animals. One important interaction involves food, or energy source.

Green plants in the ecosystem use energy from sunlight, nutrients from the soil, and carbon dioxide from the atmosphere to manufacture food. Most of this food is used for the plants' own growth and development, but some is stored in reserve. When an animal eats plants, it utilizes plant materials and food reserves for its own growth and development. Some animals obtain minerals and energy for growth and development by eating other animals instead of or in addition to eating plants.

One feeding relationship in a community of organisms is called a food chain. An example of a food chain is coconut → coconut crab → man. Coconuts make their own food but in turn become food for the crab, and crabs are food for man. The arrows designate the direction that the food, and therefore energy, move through the chain.

However, coconuts are eaten by man also. And coconut crabs may be eaten by animals other than man --- monitor lizards, for example. Since organisms are eaten by more than one kind of animal, the resulting diagram may be something like the following:



This diagram, called a food web, is made up of several food chains. A food chain that you can demonstrate in the classroom involves algae, water fleas, and fish. The chain is diagrammed as follows:

Algae ⟶ Water Flea ⟶ Fish

The water flea is a small animal related to crabs, crayfish and lobsters. In your aquarium, the fleas will probably measure up to 1/8 inch in length. Some parts of this animal are large enough to be seen with the naked eye. Children find water fleas interesting to observe, because the shell (carapace) and some of the organs are transparent. The vibrating gill feet, the single black eye, and the intestine (usually filled with green algae) show through the carapace. These parts, as well as the two large antennae that are used for swimming and therefore are not enclosed by the carapace, can be seen with a magnifier. Very often eggs are visible in the brood pouch. The eggs quickly develop into baby water fleas inside the pouch, and the young are released live.

During the spring and summer months most water fleas are females. They reproduce without mating. Under optimal environmental conditions of abundant food and water and warm temperatures, water fleas --- again mostly females --- are released; they grow rapidly and soon produce eggs.

A water flea eats various small organisms, including green algae. The green algae are digested in its intestine; the remains, which turn brown, can be readily observed in the part of the intestine near the anus. Finally, the remains (feces) pass through the anus, accumulate on the bottom of the aquarium, and become part of the detritus.

CHAPTERS IN THIS PART:

11. What Do Water Fleas Eat? In Chapter 11, the children observe water fleas, and pay special attention to the contents of the intestine and what the organism eats. Your pupils periodically observe water fleas in vials containing algae.

During this time the water fleas may reproduce and increase in number, or they may die.

12. What Do Fish Eat? In Chapter 12, water fleas are added to aquaria containing hungry fish. The children watch the fish capture and swallow water fleas. The eating relationship is diagrammed on the chalkboard as
Algae $\longrightarrow$ Water Fleas $\longrightarrow$ Fish.

13. What is A Food Web? In Chapter 13 after they acquire additional information about what the fish eat, children expand this diagram into a more complex pattern called a food web. Then they construct a food web as a class mural.

CHAPTER 11

WHAT DO WATER FLEAS EAT?

WHAT YOU WILL BE DOING:

Children culture water fleas in vials containing algae. They see the algae being consumed and observe the water fleas at close range. As they discuss the intestine, which is easily seen, children learn that water fleas eat and digest algae, excreting a brownish material called feces.

TEACHING MATERIALS:

For the team of two children:

1 magnifier
1 label
plastic vial (or baby food jar)
1 tumbler

For the class:

1 dip net (fine mesh)
1 medicine dropper
1 tumbler
1 aquarium containing a heavy growth of algae
3 jars of water fleas
1 tray
drawing paper
1 Daphnia film loop - (Daphnia is the name of a small animal, also called water flea. The film loop, if available, will provide considerable insight into the habits of water fleas.)

THINGS TO DO IN ADVANCE:

Let the students help you prepare a water flea stock culture for several activities. Pour the contents of the water flea shipping containers into the fine-mesh dip net. Then discard the water, and transfer the water fleas to an aquarium containing algae. Be certain there are no fish in this aquarium to devour the water fleas. You may wish to cut off some of the tapered ends of some of the plastic medicine droppers so the water fleas can pass through the enlarged opening more easily.

Use one gallon of aged tap water.

HELPFUL HINTS:

Prepare one vial containing three or four water fleas for each team of two students. With the students' help, half fill one tumbler with aged tap water and fill sixteen plastic vials from an aquarium containing algae. Then scoop some water fleas from the stock culture with the dip net. Immediately put the dip net into the tumbler of water, holding it so only the bottom (where the water fleas are) is in the water. Use a medicine dropper to transfer three or four water fleas to each vial.

Give one vial and magnifier to each of the teams. Tell them that the little organisms are water fleas which live in ponds and lakes with algae. After both team members have observed the water fleas, ask them to count the organisms. How many are present in each vial? The children should write their names and record the number of water fleas on a label fastened to the vial.

Afterwards, your pupils should place their vials of water fleas on a tray near a window but not in direct sunlight. Allow the children to observe their vials briefly each day for at least a week. Several events may occur during this time: (1) the water fleas may die; (2) they may produce young, with resulting increase in numbers; (3) the water may become clear because the water fleas ate most of the algae; or (4) it may become clear because the algae settled to the bottom. If the latter is the case, ask the children to gently stir or shake the vials until the algae are evenly distributed.

CLASS ACTIVITY:

If the water fleas disappear, ask the children what might have happened. Suggest that they look at the material on the bottom of the vial, where they may recognize water flea shells. On the other hand, if the number of organisms increases, ask the children where the new water fleas may have originated.

If the water in the vials has become clear because the algae have disappeared (not because they settled to the bottom), ask the students what might have happened. If your pupils have trouble remembering the color of the water at the time they set up the experiment, they can compare their vials with the green water in the aquarium. If no one in the class mentions water fleas as a possible cause of the algae's disappearance, you should suggest it.

Observing Individual Water Fleas:

1. Half fill one tumbler with aged tap water.
2. Pour the contents of the students' vials through a dip net, discarding the water.
3. Place the dip net in the tumbler. As before, hold the net so only the bottom is in the water.
4. Give each team of children one empty tumbler. Place it upside down on a sheet of white paper.

5. Use a medicine dropper to transfer two or three large water fleas to the bottom of each inverted tumbler.

Ask the students to observe the water fleas with their magnifiers. (Most children are unable to watch the actual feeding process with these low-power magnifiers. It is sufficient, at this point, for them to observe just the parts and behavior of the water fleas.)

Discussion and Drawings:

You might ask several children to draw on the chalkboard what they think water fleas look like.

Gather the children around you to discuss and compare their pictures. If they disagree about what a given part looks like and where it is located, they should observe and draw the same water flea again.

Daphnia Film Loop:

Let the children watch the film loop as long as they are interested.

With questions, draw attention to the intestine. Tell the children that the intestine is a tube with an opening --- the mouth --- at one end and another opening --- the anus --- at the other end. The intestine should be dark greenish for most of its length, because it is filled with ingested algae. Toward the anus the intestine should be brownish because of the feces it contains.

Feces:

Supply the term "feces" (FEE-sees) for this brown material, which is composed of the remains of undigested algae. Tell the children that feces are eliminated through the anus.

Show the Daphnia film loop again.

You or the children may ask, "What happens to the feces?" The resulting discussion should provide you with an introduction to the chapter on detritus (Part 6)

OPTIONAL ACTIVITIES:

1. Try repeating the same experiment using mosquito larvae. This is especially effective if you use mosquito fish instead of guppies.

CHAPTER 12

WHAT DO FISH EAT?

WHAT YOU WILL BE DOING:

Six one-gallon aquaria, each containing one hungry fish are set up at several points around the room. You add the contents of a vial containing ten to twenty water fleas to each aquarium. The fish catch and swallow the water fleas.

The water fleas had previously eaten algae. The feeding relationship involving these three organisms is diagramed like this:

Algae ⟶ Water Fleas ⟶ Fish

TEACHING MATERIALS:

For the class:

- 6 one-gallon containers
- 6 fishes
- 6 plastic vials
- 1 water flea culture (or mosquito larvae)

THINGS TO DO IN ADVANCE:

Transfer six fish to a container of aged tap water. Do not feed them for a week. Prepare six vials, each containing ten to twenty water fleas in aged tap water.

HELPFUL HINTS:

Fish Eat Water Fleas (Mosquito Larvae):

Add one hungry fish to each of six containers, and place these around the room so all the students can see them. Ask the students to quietly watch the fish while you pour one vial of water fleas into each aquarium.

Discussion:

Ask, "What happened to the water fleas?" If no one mentions food, you should say that the water fleas are food for the fish.

Write on the board: Water Fleas ⟶ Fish. Then ask the students what water fleas

eat. If they do not volunteer "algae," you should do so and then write: Algae ⟶ Water Fleas ⟶ Fish. Leave this on the board where the students can see it for a day or two, or until you begin Chapter 13.

Cleanup:

Return the fish to the original aquaria. Strain the water fleas through a dip net, and return them to the stock culture. Rinse and store the containers.

You may put a tumbler of water fleas and a medicine dropper beside an aquarium. Your pupils can add water fleas to the aquarium and watch the fish eat.

Note: The University of Guam Marine Lab people refer to the plural of 'fish' as follows: Any number of one kind is 'fish'; if individuals of more than one kind are meant, 'fishes'. Example: There are 100 fish in this tank--all are guppies. In the Personnel Office aquarium are three fishes--a turkeyfish, a grouper, and an eel.

CHAPTER 13

WHAT IS A FOOD WEB?

WHAT YOU WILL BE DOING:

The diagram first drawn in Chapter 12, Algae → Water Fleas → Fish, is further developed. Students find that the fish eat water fleas and something besides water fleas. After making this discovery, children are able to build a more elaborate diagram. Other plants and animals that are involved in a food relationship may be included. The result is a weblike diagram - a "food web."

TEACHING MATERIALS:

For the class:

- 1 water flea culture
- 1 package fish food
- drawing paper
- 1 roll butcher paper
- crayons
- paste
- scissors

HELPFUL HINTS:

Review the previous discussions by asking the students what happened when water fleas were put in the aquarium with the fish. Call their attention to the Algae Water Flea Fish diagram.

Ask your pupils if the fish eat anything beside water fleas, if any organism eats the fish, and if another eats that animal. Then ask if any other animals eat water fleas and so on. Add to the diagram the names of all organisms the children suggest. A very complex diagram might result, depending upon the children's ideas. One class suggested:

$$\begin{tikzcd}
 & \text{Goldfish} & & & \text{Alligator} \arrow[d] \\
\text{Algae} \arrow[r] & \text{Daphnia} \arrow[u] \arrow[r] & \text{Mosquito Fish} \arrow[r] & \text{Catfish} \arrow[r] & \text{Whale} \\
 & & \text{Fish Food} \arrow[u] & &
\end{tikzcd}$$

CLASS ACTIVITY:

Invention:

Tell the students the whole diagram is a picture of a food web - "food" because it shows which object is food for what other one and "web" because the arrows and the names of organisms spread out and interconnect in a weblike pattern.

If children disagree about whether a certain animal does in fact eat another, encourage them to secure evidence to resolve the disagreement. If the organisms in question can not conveniently be observed firsthand, your pupils may obtain information about them in encyclopedias and dictionaries, or other sources.

Expanding the Web:

Children's comments as they construct the water flea food web often contain hints for experiments and expansion of the web.

1. "Do Other Fish Eat Water Fleas?" If other fishes or even tadpoles* are available, add water fleas to their aquaria while students watch closely.

2. Your pupils will probably mention that fish eat fish food. Read aloud the list of ingredients on the fish food package, and let the children decide whether to add some of these names to the web. The following activities are designed to give children opportunities to discover additional examples of food webs so they may expand their understanding of the concept.

*Toad tadpoles are plentiful at Agana Springs, from time to time.

Land Food Web:

Ask the students to name an animal that lives on land, and write the name of it on the board. Then build a food web by asking the children what this animal eats until many parts of the web have been drawn. This web is likely to contain the names of many plants as well as animals and may also include "people."

Habitat:

Since the concept of habitat has already been introduced, suggest that the children confine the food webs to organisms that live in the same habitat, such as the ocean or limestone forest. In the food web diagram the children constructed at the beginning of this chapter, some of the organisms they suggested may live in freshwater and some in saltwater. You can point out that the food web has not been confined to one kind of habitat by asking such questions as, "Where do fish live?" "Where do whales live?" "Is this the same habitat?" or "How does the water where the fish live differ from the water where whales live?"

Mural:

The class can construct a food web mural, using as large a sheet of paper as you consider feasible. On another sheet of paper each child may draw and cut out a picture of a plant and one of an animal. Select one picture at random, paste it to the mural paper, and write the name of the organism beneath. Ask if anyone has a picture of something that this organism eats or of something that eats it. Paste these pictures to the paper and label them; then let the children draw arrows to indicate feeding relationships (what is food for what?). Organisms can be grouped according to habitat.

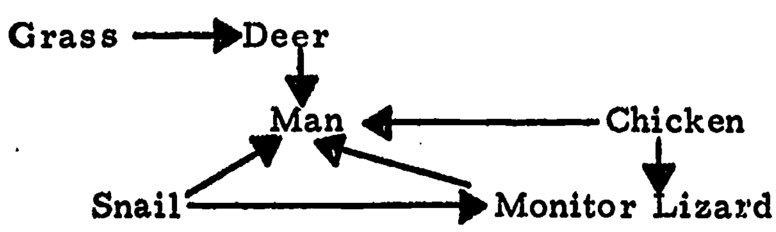
After a number of pictures have been placed on the mural, students will discover that more than just a single arrow can be drawn for each new organism. They will begin to see how very complex this web can be. Not all pictures need to be fitted into the web on the day the mural is begun; the class can start building it with just a few pictures, adding more later. By looking at and working on the mural from time to time for several weeks, children will begin to see more and more relationships.

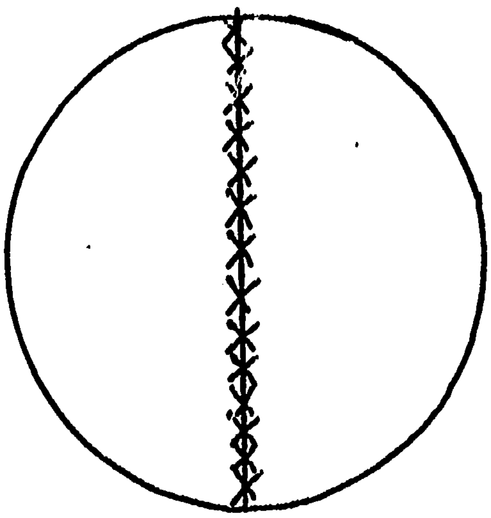
Meanwhile, individual pupils may draw food webs of their own choosing, using either names or pictures of organisms.

OPTIONAL ACTIVITY:

1. Ask the students to use crayons and paper to draw a field of grass with a fence across the middle, as shown to the right.

   Draw the following food web on the chalkboard:





   Ask the students to use the food web to decide which animals could be placed in the field on one side of the fence and which on the other. Tell them that the animals that can be kept together on one side of the fence are those that do not eat each other. Have the children print the names of the animals on their drawings.

PART 6
DETRITUS

OBJECTIVES FOR THE STUDENTS: At the end of Part 6, the student should be able to:

...describe changes in the material on the bottom of the aquaria.
...collectively propose and test hypotheses about the changes in the material on the aquarium bottom.
...use the term "detritus" for decaying matter in the aquaria.
...describe the effect of detritus on plant growth.

BACKGROUND INFORMATION AND SUGGESTIONS: In Part Six the children's attention is directed to the accumulation of detritus in the aquaria. The children speculate on the origin of detritus and carry out experiments to test their ideas. They help set up an experiment comparing the growth of seedlings in sand alone and in sand fortified with detritus.

Soil is important to all organisms because it contains minerals that plants use for their growth and food production. Without such food production, there would be neither food chains nor web --- no life. The minerals present in soil originated in the rocks. So long as rocks exist so will minerals. However, the decomposition of rock that frees minerals for plant use occurs slowly. Further, not enough minerals are produced by this means to support the quantity of plant growth that is on the earth today. The extra minerals needed come from the waste products and dead bodies of plants and animals (organic material).

Organic waste products and the dead bodies of plants and animals are gradually decomposed by bacteria and molds. As a result, minerals that have been incorporated into the bodies of these organisms are once more returned to the soil where they can be absorbed and used by plants.

The gradual deposition of "dark stuff" in aquarium sand represents the much larger accumulation of organic matter on the earth's surface. The dark material in an aquarium is "detritus" and consists of partly-decomposed organic matter - dead plants and animals and feces from fish, snails, and water fleas.

CHAPTERS IN THIS PART:

14. What Is The "Dark Stuff   A new aquarium is prepared for comparison with

an "old" aquarium containing large amounts of detritus. After observing the differences between the two aquaria, the children generate ideas about the sources of the detritus. They experiment to find these sources.

15. Soil Fertility: With the help of your pupils, you perform an experiment to determine the effect of detritus on the growth of young plants. Forty ryegrass seeds are planted in sand mixed with detritus collected from the aquaria. The other setup contains the sand and ryegrass seed, but no detritus. After the ryegrass plants have grown for several weeks, they are compared for differences in size and color. The children are asked to explain the differences.

16. Dismantling the Aquaria: The contents of the classroom aquaria are distributed to the children to take home and care for. The children transfer organisms from the aquaria to plastic bags. They carry the organisms home in the bags and set up their own aquaria.

    If any organisms are left over, put them all into one aquarium. Cover this aquarium with a lid to prevent evaporation of water and let it stand. The class observes the aquarium over a period of months.

CHAPTER 14

WHAT IS THE "DARK STUFF"?

WHAT YOU WILL BE DOING:

A new aquarium is prepared for comparison with an "old" aquarium containing large amounts of detritus. After observing the differences between the two aquaria, the children generate ideas about the sources of the detritus. They experiment to find these sources.

TEACHING MATERIALS:

For the class:

1 one-gallon container
1 baster
2 cups sand (optional)
medicine droppers

10 to 30 tumblers

magnifiers
2 sprigs Hydrella

4 to 5 fish

4 to 5 small snails

1 water flea culture (mosquito larvae)
1 aquarium containing detritus
30 labels
1 dip net (coarse mesh)

THINGS TO DO IN ADVANCE:

Use aged tap water. Rinse sand for the new aquarium.

HELPFUL HINTS:

Prepare a new aquarium in front of the children. Place sand in the bottom of the container before you add the aged tap water. Then transfer one or two plants from another aquarium and with a dip net add several mosquito fishes and snails.

Place one of the older aquaria beside the new one. Be sure to select an aquarium with a distinctly visible accumulation of detritus on top of the sand.

CLASS ACTIVITY:

Ask the students to compare the two aquaria and to describe any differences. If no one mentions the detritus, point it out, asking the children what they think it is and where it came from. Let them discuss these questions among themselves for a minute or two. They may suggest experiments even though they can not agree on what to call it. Tell the students that this material is called Detritus.

Ask the children to tell where they think the detritus in the water flea culture came from. The children should relate detritus to feces produced by water fleas. If they do not, remind them of the Daphnia feces they observed in the film loop (if you used it) and ask them where eliminated Daphnia feces go.

Ask your pupils to predict some changes they think might take place in the new aquarium during the next week. Help them record their predictions.

The students will probably look eagerly for daily evidence that might confirm their predictions. You might occasionally ask them for evidence of a source of detritus.

Let the students discuss their observations and their ideas about the source of detritus. List the ideas and divide the class into as many groups as there are ideas. They might mention fish feces, plant leaves, and dead fish and snails. If they do not, ask them to look for these in the aquarium.

Your pupils might set up experiments with the following objects to test their ideas: fish and water, snails and water, plants and water, sand and water, or fish food and water. Each investigation can be set up in a tumbler. The children should label each tumbler with their names, the organisms it contains, and the date.

After the experiments have been set up, hold up a tumbler containing only aged tap water. Ask the students if they need this as a part of their experiments. If they say yes, ask them why. If they say no, ask them why not. The tumblers containing only aged tap water can serve as controls to ensure that detritus does not come from the water. Aged tap water probably will be a part of every experiment.

Further Evidence:

Remove some detritus from the water flea stock culture with a medicine dropper or baster, and place it on an inverted tumbler. Leave the detritus where the children can observe it with magnifiers. Do they notice the cast-off carapaces? Which of the organisms in the tumbler produces the most detritus?

Cleanup:

Return the organisms to the aquaria. Wash and store the tumblers.

CHAPTER 15

SOIL FERTILITY?

WHAT YOU WILL BE DOING:

With the help of your pupils, you perform an experiment to determine the effect of detritus on the growth of young plants. Forty ryegrass seeds are planted in sand mixed with detritus collected from the aquaria. The other setup contains the sand and ryegrass seed, but no detritus. After the ryegrass plants have grown for a few weeks, they are compared for differences in size and color. The children are asked to explain the differences.

TEACHING MATERIALS:

For the class:

baster
aquaria containing detritus
2 tumblers or other planter cups (e.g. milk cartons)
2 cups sand
1 stirring stick
1 dip net (fine mesh)
2 labels
80 ryegrass seeds
1 light source
3 sprinklers

HELPFUL HINTS:

Collecting Detritus:

With your pupils' help, collect as much detritus as you can from the aquaria. Su~k the detritus off the sand with the baster. Empty the baster in a fine mesh dip net, and let the water run through. Empty the dip net into a tumbler. Repeat this procedure until you have collected all available detritus. You will collect some sand along with the detritus, but this will not affect the result of the experiment.

Preparing the Sand:

Wash enough sand to fill a couple of tumblers. (See instructions for cleanup, end of Chapter 16.) Half fill two tumblers with the washed sand. To one of them, add the detritus collected from the aquaria. Mix the detritus and sand thoroughly. Add

more sand to the other tumbler to bring the level equal to the mixture of sand and detritus.

Planting Seeds:

Plant about forty ryegrass seeds in each labeled tumbler and place the tumblers in the light. Water the tumblers. Ask the children to predict what might happen to the seeds growing in these tumblers.

Observing the Results:

Two or three weeks later, there should be a noticeable difference between the two setups. The children should compare and describe the seedlings grown in unfertilized sand with those grown in sand and detritus. Remind them that one tumbler contains detritus while the other does not, and ask them what explanation they can give for the differences in the seedlings.

Cleanup:

Throw out the plants. Save the sand. Wash and store the tumblers.

CHAPTER 16

DISMANTLING THE AQUARIA

WHAT YOU WILL BE DOING:

The contents of the classroom aquaria are distributed to the children to take home and care for. The children transfer organisms from the aquaria to plastic bags. They carry the organisms home in the bags and set up their own aquaria.

If any organisms are left over, put them all into one aquarium. Cover this aquarium with a lid to prevent evaporation of water and let it stand. The class observes the aquarium over a period of months.

TEACHING MATERIALS:

For the class:

- 6 aquaria
- 2 dip nets (fine mesh and coarse mesh)
- 32 plastic bags with ties (small tin cans may be used to place the plastic bags into after the fish, etc. have been added).
- 1 baster
- 1 aquarium with lid (provided by the teacher)

HELPFUL HINTS:

Tell the students that each one may build his own aquarium at home from the contents of the class aquarium.

If there are not enough organisms so that each child can have one of each kind, devise some method of parceling them out.

Give each child a plastic bag and wire tie. Ask him to squirt two full basters of aged tap water into his bag. Then, using the dip net, baster, or just his hands, he transfers the organisms from the class aquaria to his plastic bag.

Questions such as the following will help them review the concepts presented in the unit:

- What organisms are you taking home?
- What will you do to prepare a habitat for these organisms?
- What will you feed them? What else do they eat? Does anything eat them?
- What changes may occur in your aquarium? What will cause these changes?

Ask the children to report what they actually did with their organisms when they got them home.

Cleanup:

To wash the used sand, fill each aquarium with water, stir the sand in the water, and then pour the water off. If the procedure is repeated several times, the detritus is washed away. Let the sand dry before storing it for future use.

ACTIVITY 1A SETTING UP AND OBSERVING A SALTWATER AQUARIUM

WHEN CAN YOU USE THIS ACTIVITY?

1. You could use it in place of Activity 1 SETTING UP AND OBSERVING FRESHWATER AQUARIUMS.

2. You could use it in any time during the year.

SYNOPSIS (WHAT WILL YOU BE DOING?)

The class sets up a saltwater aquarium. They go on a field trip and get organisms for their aquarium. They observe the aquarium and discuss the organisms in .. They discuss changes that take place in the aquarium. You (the teacher) choose other ways to use the aquarium from a list of suggestions.

OVERVIEW OF THIS ACTIVITY (WHY ARE YOU DOING THIS?)

As the children set up and observe the saltwater aquarium, they get actual experience with several populations of organisms. They get practice in observing and describing the changes and activities they observe in the aquarium.

This saltwater aquarium can be used to show predator-prey, changes in populations, plant eaters and animal eaters, food chains and webs. What the children see in this aquarium gives them experiences for use in many of the other activities in this unit. It also gives you a source of student interest to start many new experiment.

MATERIALS

For the class:

aquarium - two gallon or larger/ten gallon is a good size
masking tape
fish food (optional)
containers to carry saltwater in - plastic buckets
beach sand (washed)
several rocks or pieces of coral (for fish to hide in)
clean saltwater
paper
small fish net
containers for catching organisms
large net (optional)

air pump
filter
air stone (optional)
hose to hook the pump to the filter

> If you cannot use a pump and filter at your school, read page 126. This tells you how to set up a saltwater aquarium without pumps or filters.

PREPARATION

Read: "How To Take A Field Trip" on page 110,
"How To Set Up An Aquarium" on page 116, and
"A Beach Field Trip" on page 114.

Find the beach you are going to on the field trip to get the organisms. It must be a safe place. You will need another adult (teacher or parent) to go with you. Make arrangements for this adult and transportation. Get the parent's permission for the field trip if it is the school's policy.

TEACHING SUGGESTIONS

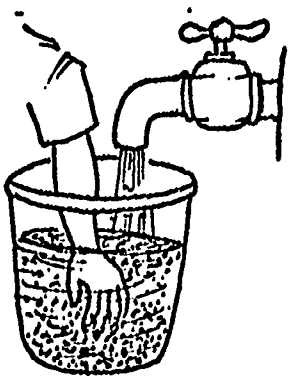
First And Second Day-Getting The Aquarium Ready

1. Ask the children if they have seen an aquarium before. Let the class discuss aquariums they have seen and what an aquarium is.

   Ask: "What would you need to make an aquarium for organisms from the ocean?"

2. Divide the class into three groups. Each group would be responsible for one of these jobs:

   Group #1 - Get enough beach sand to cover the bottom of the aquarium. The sand should be washed before putting it in the aquarium.

   Group #2 - Get enough clean salt-water to fill the aquarium.

   Group #3 - Get several rocks and dead pieces of coral to put on the sand in the aquarium. Not too many. Just enough for the fish to hide in.

3. Get the water, sand, and rocks into the classroom. You could do it by:

   Suggestion #1 - Take the children to the beach and let them bring the materials back.

   Suggestion #2 - Let some volunteers help you get the materials before class.

   Suggestion #3 - You (the teacher) get the materials before class.

   Use one of these examples to get the materials into the classroom.

4. Let each group put its materials into the aquarium.

   Group #1 - Put in the washed sand.

   Group #2 - Put in the clean saltwater.

   Group #3 - Put in the rocks and coral.

   Hook up the pump.

   Let the children put a piece of tape on the aquarium to mark the water level.

5. Tell the class: "Tomorrow we can get organisms out of the ocean for the aquarium."

   Discuss the following: What they are going to get.

   Where you are going.

   What they need to take along. (nets, jars, buckets)

   How you should dress.

   Rules for the field trip. (Be sure they know these.)

   You can only put a couple of each kind of organism in the aquarium. Don't get a lot of one kind of animal.

Third Day-Getting The Saltwater Organisms

1. Be sure the class knows their responsibilities. Check the above list before you start on the field trip. DID YOU READ "HOW TO TAKE A FIELD TRIP", "HOW TO SET UP AN AQUARIUM", "A BEACH FIELD TRIP"?

2. Take the children on the "beach field trip".

3. After the field trip:

   Let the children put their organisms into the aquarium. Remember don't put too many organisms in the aquarium.

Fourth Day-Observing The Aquarium

1. Let the children observe the aquarium. It is best to do this in small groups if possible.

2. Let the children make their own record of what is in the aquarium.

   Give them a sheet of paper. Let them draw the organisms.

   Some children may be able to write down the names of some organisms.

3. Discuss the aquarium. Below are some suggested questions:

   "How many kinds of animals are in it?"

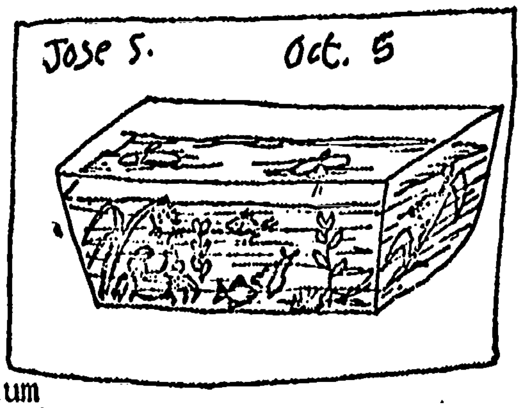
   "How many kinds of plants are in it?"

   "What do you know about these animals?"

   "Do you eat any of these organisms?"

   "What do these animals eat?"

   "What can we feed the animals?"



Later Days-Things To Do With The Saltwater Aquarium

YOU CAN USE THIS AQUARIUM FOR MANY THINGS. IT IS MORE THAN JUST A PRETTY THING IN THE CLASSROOM. BELOW ARE SUGGESTED WAYS TO USE THE SALTWATER AQUARIUM. YOU CAN PROBABLY THINK OF MANY MORE.

Suggestion #1 - Observe it once a week. Discuss changes that happen. "What happened?" "Why do you think it happened?"

Suggestion #2 - Use it with Activity 2 Populations. The children can talk about the populations in the aquarium.

Suggestion #3 - Use it with Activity 3A Brine Shrimp and Fish. The children can put brine shrimp into the aquarium and observe what happens.

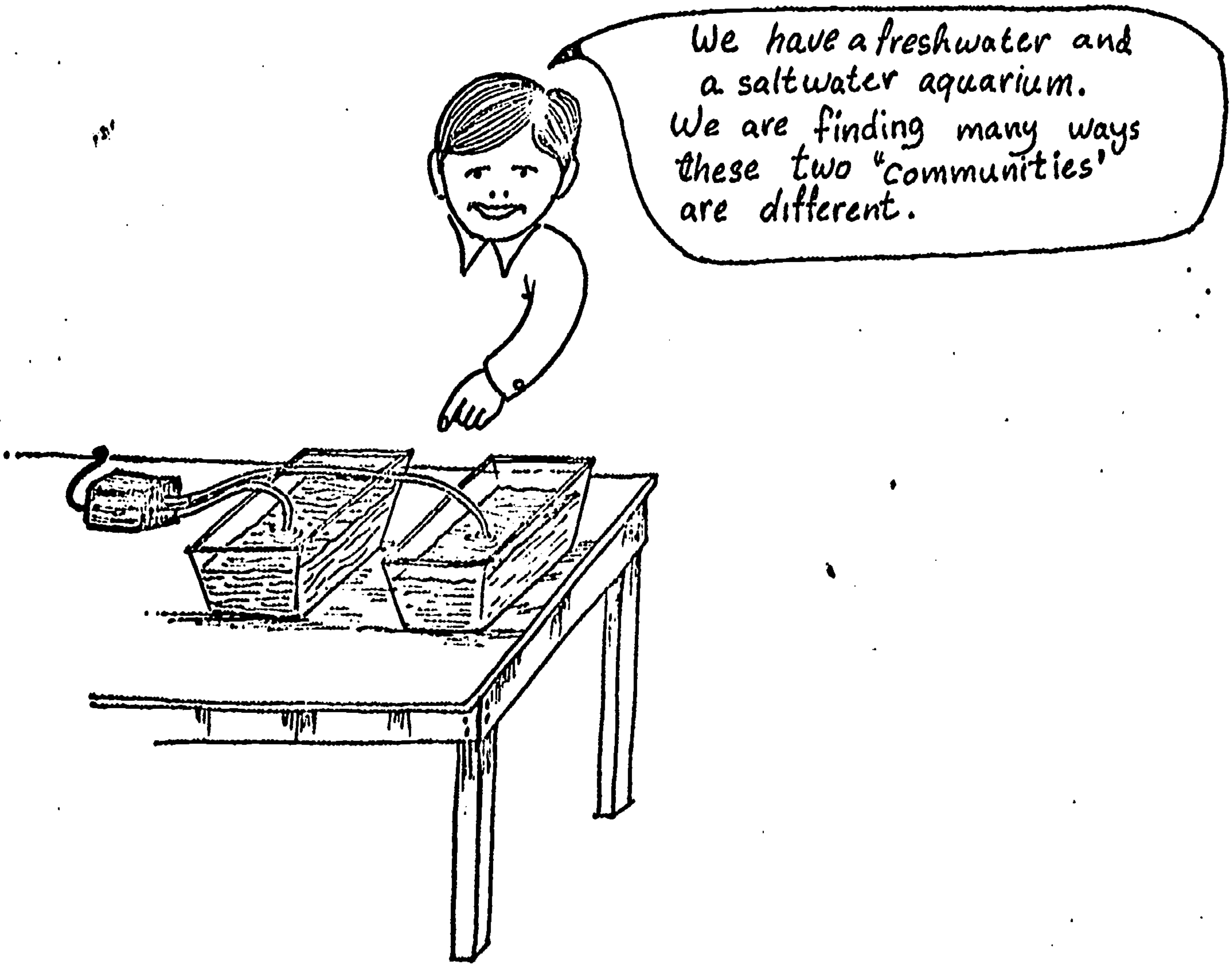
Suggestion #4 - Use it as part of any of the following activities: Activity 9 Plant Eaters and Animal Eaters, Activity 10B Predator-Prey Relationship, Activity 12 Food Chains, Activity 13 Food Webs.

Suggestion #5 - Listen to what the students say. Do experiment to answer questions they ask. For example:

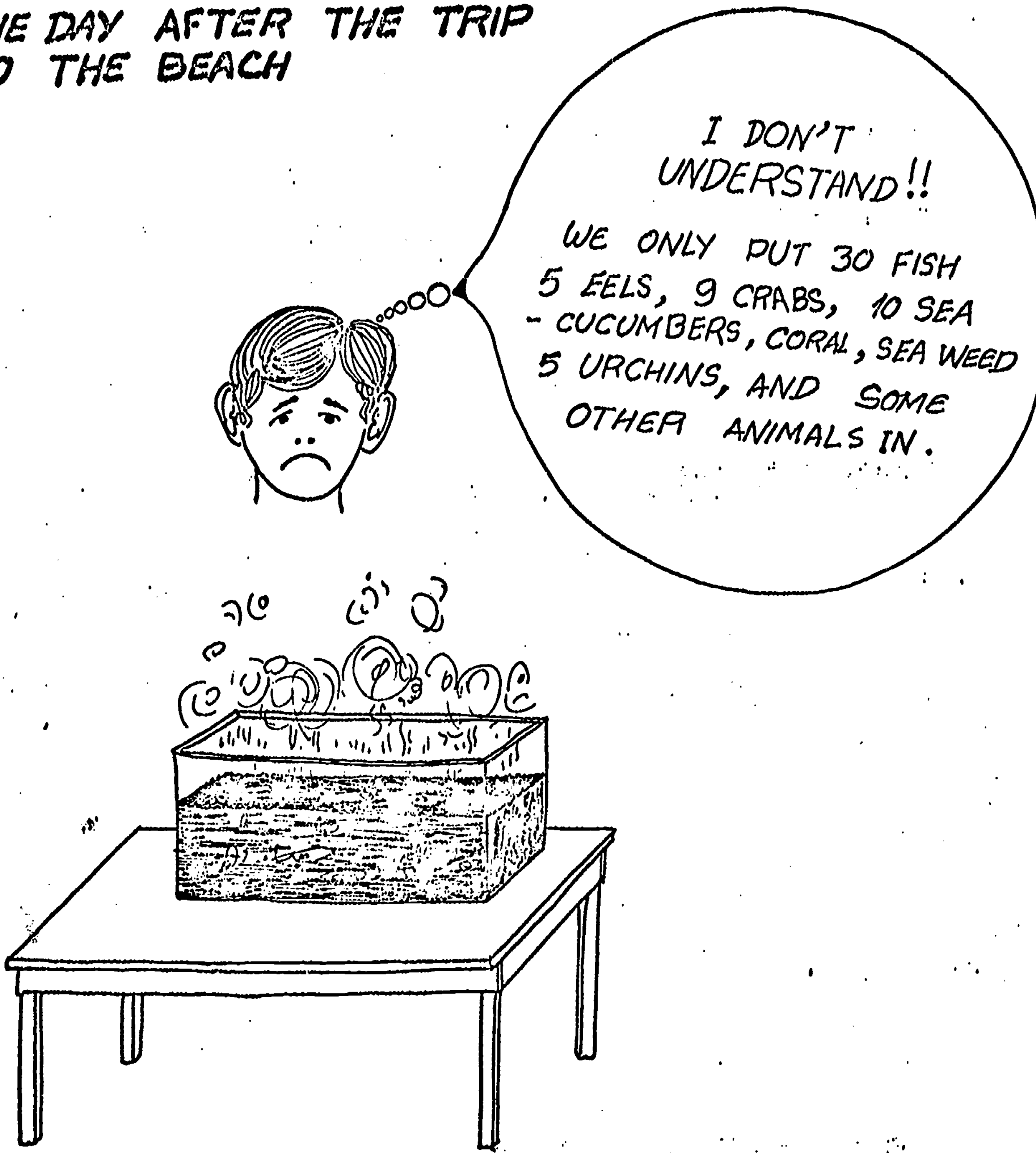
"Will the mosquito fish live in the saltwater? Will the saltwater fish live in the freshwater?"

"What will they eat?"

"What animal is eating the fish? Is it that crab?"



THE DAY AFTER THE TRIP TO THE BEACH



What can I do if my plastic aquarium leaks?

Some aquariums can be sealed by brushing a little bit of chloroform on the crack. This will dissolve the plastic and seal it as it dries.

You can brush polyester resin over the cracks. This resin can be bought from Sears or places that have fiber glass for boats. Large cracks or holes can be repaired by using fiber glass cloth with the resin.

Try Elmer's Glue - squeeze a ribbon of it along the crack.

Can I have a saltwater aquarium without any air pump?

Yes, but you will have to experiment to see what will work for you. Here are some suggestions for keeping an aquarium without an air pump:

1. Use a large aquarium and a small number of organisms.

   OR

   Use a small aquarium and only one or two small organisms.

2. Keep the aquarium uncovered.

3. Get your organisms from the tide pool areas on or close to shore. These organisms are better adapted to a severe and changing environment.

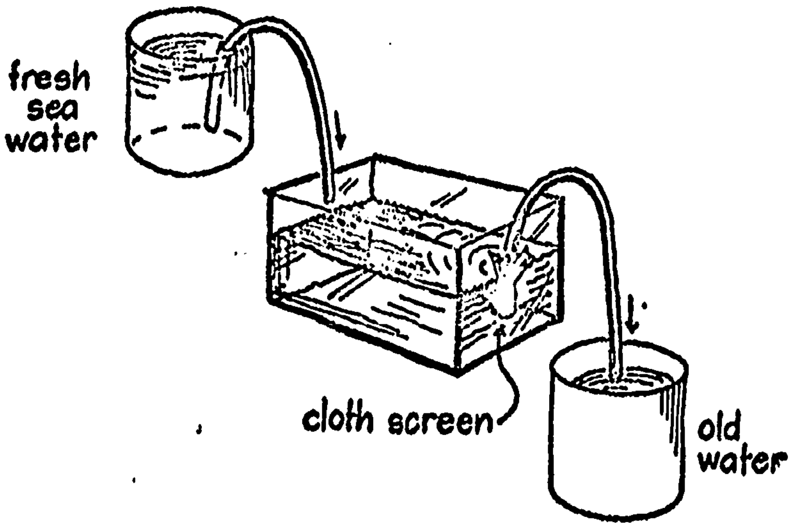
4. Only plan to use the aquarium for a short time. For example, observe the organisms for a week and then set up a new aquarium with different organisms.

5. Observe organisms other than fish. Many other organisms are interesting for an aquarium. For example, put in sea shells, or crabs, or sea urchins, or small starfish. Many of these organisms will live under environmental conditions that kill fish.

6. You could try keeping more delicate organisms in an aquarium by changing the water each day.

   Use two siphon hoses. Put a cloth screen over the end of the hose that will siphon the water out of the aquarium. The screen will stop any organisms from being sucked out.

Siphon new water into the aquarium as after you siphon almost all of the old water out of the aquarium.



This requires a lot of work and attention. It might be worth doing for a short time, like one school week.

Try several aquariums and see what happens. The best advi e to follow is:

USE LOTS OF WATER AND ONLY A COUPLE ORGANISMS.

GLOSSARY

aged tap water - Tap water that has been standing in an open container long enough to allow the chlorine gas to escape (on Guam, say 24 hours).

algae - (Al-jee, plural; Al-ga, singular) A group of "simple" plants without roots, stems, leaves, or flowers; most species are microscopic and green. Some algae cause "green water" in aquaria and the matted masses of green, threadlike "pond scums" in streams. The red, brown, yellow, green, and blue-green seaweeds of the ocean also are algae.

animal eater - An animal that eats other animals for an energy source; a predator.

anus - ($\bar{A}$-nus) The opening at one end of the intestine through which an animal expels feces.

aquarium - (plural: aquariums, aquaria) A container with water in which water-dwelling plants and animals live; also a building housing aquatic organisms.

bacteria - A group of microscopic organisms; some are decomposers that break down (decay) feces and dead organisms. Bacterial action can often be recognized by a foul odor

biotic potential - The theoretically largest possible increase of a population, assuming maximum birth and no death.

carbon dioxide - A colorless, odorless gas contained in the atmosphere and given off by both plants and animals as one result of respiration.

community - A group of plants and animals which lives in the same area, dependent on one another for food and other requirements.

competitors - The name applied to two or more organisms or populations using the same food, space, raw materials, light, etc.

condensation - The conversion of a material from gaseous to liquid state.

consumers - The group of animals in a community which eats plants or other animals. Consumers make up one functional group in the community. The other functional groups are producers and decomposers.

cotyledon - (cot-i-LEE-dun) "seed leaf") There are two basic kinds of flowering plant; those with one seed leaf such as corn and other grasses, and those with two seed leaves, for example, others we eat (beans, peas, peanuts). Cotyledons are, botanically, food stored for the embryo plant during the germination.

culture - (verb) To establish optimal growing conditions for particular organisms in order to obtain large numbers of those organisms. (noun) The organisms living under such conditions.

decay - Breakdown of organic material by the digestive action of microorganisms such as molds, bacteria, and yeasts.

decomposers - That group of organisms in a community (usually bacteria, yeasts, and molds) which causes decomposition (decay) of organic matter, releasing raw materials to the environment.

detritus - (de-TRI-tus) An accumulation of feces and dead plant and animal material. Detritus may also consist of rock and other material that has been worn down into small particles.

develop - To pass from one stage of growth to the next, recognizable by the appearance of new structures such as tendrils on pea plants and legs on tadpoles. (See grow)

digestion - The process by which food is broken down into chemically usable form by organisms.

ecology - The study of plants and animals and where they live. The study of organisms and their interrelationships with their environment.

ecosystem - (EE-co-system) The interacting plants, animals, and their nonliving environment (substrate, water, temperature, sunlight) in any given place.

embryo - An organism in its first stages of development.

embryo plant - The part of a seed that grows into a new plant. In a bean, pea or peanut the embryo lies between the two cotyledons.

energy - The ability to perform work, which is the moving of matter - whether a molecule in air, or an earthquake.

environment - The combination of all external factors that affects and influences the growth, development, and reproduction of an organism. Includes other organisms.

environmental factor - Any part of the environment, such as a chemical, water, or light, that affects an organism, and to which it responds. Includes other organisms.

feces - (FEE-sees) The waste matter which passes out of the anus of an animal. Includes a large proportion of bacteria and their products.

fertilization - The union of sperm and egg cells that starts the development of an embryo.

fertilizer - An artificial or natural source of minerals used by plants.

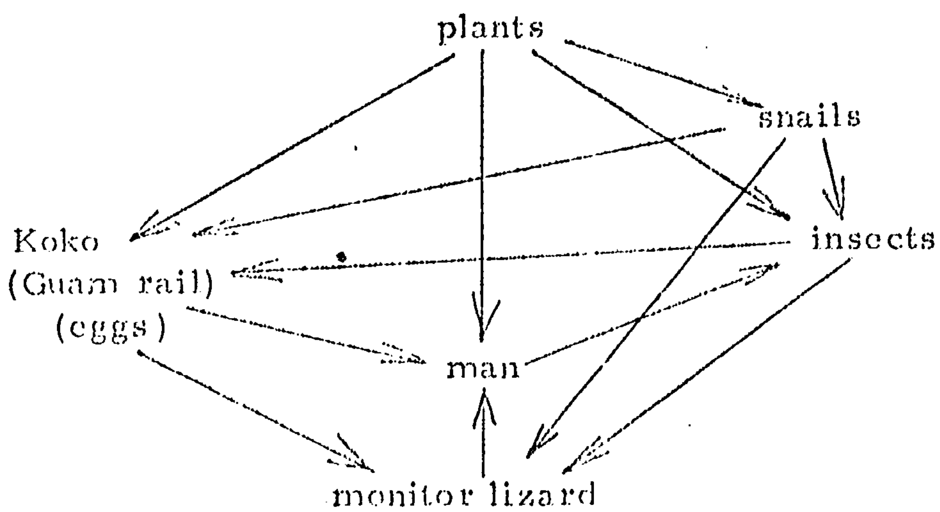
flower - The reproductive structure of a seed-bearing plant, within which fruits begin to form.

food - That combination of raw materials used by plants and animals for nourishment. Plants make food by the process of photosynthesis. Food is stored energy.

food chain - A straight-line diagram showing the food relationships between food and eaters. For example: rice ⟶ man; tomato leaves ⟶ grasshopper ⟶ praying mantis; leftover rice ⟶ cockroach ⟶ shrew.

food-mineral cycle - The transfer of minerals from the soil to producers (where they are incorporated in the food manufactured by plants), to consumers, to decomposers, and then to the soil where they are available again for use by plants.

food web - Two or more interconnected food chains, such as:



fruit - The ripened ovary that develops from a flower and contains seeds.

generation - All organisms of the same kind "born" at about the same time.

genetic identity - The similarity between parents and their offspring due to the transmission of distinguishing characteristics.

germinate - To begin a new stage of growth; to sprout.

grow - To increase in size. (See develop.)

habitat - The place where a plant or animal normally lives, for examples: pond - mosquito fish, open sea - shark, sand - beach morningglory, dwellings - cockroaches, under fingernails - bacteria, tall grass - rail.

humidity - Moisture, dampness, in the air.

intestine - A tubular part of the body which absorbs foods as they pass toward the anus of an animal. In some organisms (e.g., Daphnia) the entire mouth-to-anus tube is called the intestine. In other organisms (e.g., humans) the part of the tube nearest the anus is called the intestine, and parts of the tube nearer the mouth are called the esophagus, stomach, etc.

larva - The first stage after hatching of any animal that undergoes metamorphosis, such as the tadpole. In insects the larval form is often wormlike.

life cycle - The sequence of changes as an organism develops from an egg to an adult which in turn produces eggs or sperm that give rise to the next generation. For example, the beetle life cycle includes egg, larva, pupa, and adult that produces eggs or sperm.

metamorphosis - The change in body structure occurring in the development of animals in which the adult is entirely different from the young. (e.g., egg → caterpillar → pupa → butterfly; egg → nymphs (several stages) → grasshopper.

minerals - Naturally-occurring inorganic substances. Some minerals are released to the soil by decomposers and are used by plants.

mold - A kind of decomposer characterized by a fuzzy appearance. Molds may be any of several different colors.

<u>molt</u> - The shedding of skin, feathers, hair, etc., by animals, such as the skin of beetle larvae and anoles (lizards on Guam often miscalled chameleons).

<u>niche</u> - (nitch) All the activities of <u>one</u> species in an ecosystem, the total relationship of one species to its environment. Niches are separate and do not overlap.

<u>optimum range</u> - That section of the extent of an environmental factor in which an organism lives best. (see range)

<u>organic</u> - Something that is or was part of a living plant or animal; the remains of a dead organism can be called organic material.

<u>organic matter</u> - Animal wastes and dead organisms (plants and animals).

<u>organism</u> - An individual living thing; any plant or animal.

<u>ovipositor</u> - A tube extending outside the abdomen of certain female insects, such as grasshoppers, through which they lay eggs.

<u>oxygen</u> - A colorless, odorless gas contained in the atmosphere. It is produced by photosynthesis and is used by both plants and animals in respiration.

<u>oxygen-carbon dioxide cycle</u> - The exchange of gases between organisms and their environment.

<u>photosynthesis</u> - The process by which green plants manufacture food (i. e. themselves) from carbon dioxide and water with light as the source of energy. Oxygen is released as a by-product.

<u>plant eater</u> - An animal that eats plants as source of food (energy).

<u>pollutant</u> - Any substance that is added to an ecosystem in a quantity harmful to organisms.

<u>population</u> - A group of organisms of the same kind living in a particular area. Population size is determined by the number of individuals in the group. (Three ants is a larger population than two elephants.)

<u>precipitation</u> - Moisture that falls to the earth, such as rain, (snow, hail, sleet). Does not include dew which is condensation and doesn't fall.

<u>producers</u> - Green plants. They produce food that supports all organisms in a community, directly (plant eaters) or indirectly (animal eaters).

pupa - Transition stage between larva and adult of many insects that undergo metamorphosis. Also called chrysalis. May live in a cocoon.

range - All the intensities of an environmental factor between a minimum and a maximum. A range in the amount of water may be from dry to soaked. (See optimum range.)

raw materials - The chemicals, such as water, carbon dioxide, oxygen, and minerals, that are incorporated into the food produced by green plants.

reproduction - The process by which new members of a species are produced.

respiration - Energy release. The process by which energy contained in stored food molecules is released for other life processes such as movement, growth, making of new tissues, digestion, etc. It occurs CONTINUALLY in ALL live plants and animals. Any organism living where oxygen is available uses it in respiration and gives off carbon dioxide.

seedling - Young plant that sprouts from a seed.

species - Difficult to define but it is generally accepted that if two individuals can together produce offspring which can mate and reproduce then they are of the same species.

terrarium - A container in which land organsims can live.

variable - Any factor which can affect the result of any experiment. A valid experiment tests only one variable at a time.

variation - Differences in appearance and response among organisms of the same kind.

water cycle - The exchange of water between earth and its atmosphere as a result of evaporation and condensation.

yeasts - The decomposers that usually break down (decay) fruits. The action of yeasts is similar to that of molds and bacteria.